REVISED DRAFT

City of Oakland, California
Vegetation Management Plan

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EXECUTIVE SUMMARY

This Revised Draft Vegetation Management Plan (VMP) describes the actions that the Oakland Fire Department (OFD) will continue to take over the 10-year Plan timeframe to reduce fire hazard on 1,924 acres of City-owned land and along 308 miles of roadway in the City of Oakland's designated Very High Fire Hazard Severity Zone (VHFHSZ). The VMP has been developed to meet its stated goals of reducing wildfire hazard on City-owned land and along critical access/egress routes, reducing the likelihood of ignitions and extreme fire behavior to enhance public and firefighter safety, avoiding or minimizing impacts to natural resources, and contributing to regional efforts to reduce wildfire hazard in the Oakland Hills.

The Oakland Hills present a complex wildfire environment that presents a significant risk to public and firefighter safety and the built and natural environment. This area is one of the highest risk areas in the country for devastating wildland urban interface (WUI) fires, and is the location of one of the state's most destructive historic wildfires, the 1991 Tunnel Fire. Lessons learned from this and more recent, devastating wildfires in Northern California highlight the importance of managing vegetation to reduce wildfire hazard.

Development of this Plan included a detailed assessment of wildfire hazard, which was used to identify and map areas with high ignition potential or where extreme wildfire behavior would be expected, given current terrain and fuel conditions. Plan development also included coordination with OFD personnel and significant public and stakeholder outreach to better understand current vegetation management activities in the Plan Area. Vegetation treatment projects were then identified and prioritized based on proximity to Plan Area structures, roads, ridgelines, and park access gates, where fire behavior is anticipated to be extreme (high flame lengths and/or crown fires), and where continuation of the City's goat grazing program would effectively maintain lower fuel loads. Identified priority projects total 1,366 acres within the Plan Area's 1,924 total acres. This Plan also prioritizes vegetation management along 30 miles of primary access/egress routes in the Plan Area.

This Plan also outlines measurable vegetation treatment standards, by dominant vegetation type, and identifies a range of vegetation management tools that can be utilized by OFD, or its contractors, to reach these treatment standards. As vegetation is dynamic in nature, this Plan outlines an adaptive field assessment and work plan development process to be implemented by OFD annually, which accounts for the variability in vegetation condition project site conditions over time.

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
BAAQMD	Bay Area Air Quality Management District
BMP	best management practice
CAL FIRE	California Department of Forestry and Fire Protection
CAL-IPC	California Invasive Plant Council
CEQA	California Environmental Quality Act
City	City of Oakland
CSSC	Chabot Space and Science Center
CWPP	The Alameda County Community Wildfire Protection Plan
EBMUD	East Bay Municipal Utility District
EBRPD	The East Bay Regional Park District
EIR	Environmental Impact Report
FHSZ	Fire Hazard Severity Zone
GIS	geographic information system
HCP	Habitat Conservation Plan
Horizon	Horizon Water and Environment
Intermix	Wildland Urban Intermix
OFD	Oakland Fire Department
OWLS	Oakland Wildland Stewards
PRC	California Public Resources Code
USFWS	U.S. Fish and Wildlife Service
VHFHSZ	Very High Wildfire Hazard Severity Zone
VMP	Vegetation Management Plan
VOC	volatile organic compound
WHR	California Wildlife Habitat Relationship System
WUI	Wildland Urban Interface

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1 INTRODUCTION

The Oakland Hills exhibits a complex wildfire environment that presents a significant risk to public and firefighter safety and the built and natural environment. This region has been subject to numerous damaging wildland fires, is influenced by local extreme wind and weather conditions (including Diablo wind events), has steep and varied terrain, and enjoys a complex mosaic of different vegetation types. It is one of the highest risk areas in the country for devastating wildland urban interface (WUI) fires, including one of the state's most destructive historic wildfires, the 1991 Tunnel Fire, which destroyed 2,900 structures, injured more than 150 people, and killed 25 people (CAL FIRE 2019a). The portion of the Oakland Hills within the City of Oakland (City) has been designated a Very High Wildfire Hazard Severity Zone (VHFHSZ).

Of the variables that comprise the wildland fire environment (weather, terrain, and fuels [vegetation]), vegetation is the only variable that can be managed. The goal of vegetation management, as identified in this Vegetation Management Plan (VMP or Plan), is not to remove all vegetation wholesale, but to target vegetation management activities to minimize the potential for ignitions, crown fires, and extreme fire behavior by reducing and maintaining fuel loads and altering the structure, composition, and spacing of retained vegetation. Conducted in strategic and prioritized locations, vegetation management enhances fuel/fire breaks, provides defensible space around structures and assets, provides space for staging areas, and enhances ingress and egress routes. Managing vegetation at City-owned parcels and along roadways also creates strategic fuel breaks. These fuel breaks function to compartmentalize wildfires, modify their progression patterns across the landscape, and improve the ability to control or combat wildfire once started.

This VMP outlines a framework for managing fuel loads and vegetation arrangements on City-owned properties and along roadways in the City's VHFHSZ and acknowledges that vegetation is a dynamic component to wildfire hazard necessitating an adaptive management approach. The goals, objectives, and recommendations identified in this Plan are based on existing field conditions and the principles of vegetation management for fire hazard reduction. This VMP includes specific measures and treatments that have been identified and prioritized to reduce and maintain lower fuel loads in high fire hazard areas (FEMA 1992).

This VMP does not propose vegetation type conversion as an end goal or strategy in and of itself; rather thinning vegetation and providing, creating, and maintaining adequate spacing between retained vegetation is the primary management strategy to reduce the potential for ignitions and the likelihood of extreme fire behavior. This VMP also identifies best management practices (BMPs) to be implemented during vegetation management activities to reduce or avoid impacts to natural resources present in the Plan Area. (A glossary of terms used in this VMP is provided in Appendix A.)

This Revised Draft VMP has been prepared with stakeholder input gained through a variety of outreach efforts including questionnaire responses, direct written comments on the scope and extent of the Plan, direct written comments on an earlier draft version of the Plan (May 2018), public meetings with stakeholders, and site visits with stakeholders.

California faces a dramatic increase in the number and severity of wildfires. Fifteen of the 20 most destructive wildfires in the state's history have occurred since 2000; ten of the most destructive fires have occurred since 2015 (CAL FIRE 2019a). During development of this Revised Draft VMP, numerous significant, catastrophic wildfires have occurred in California, including several in Northern California. The 2017 Nuns, Tubbs, and Pocket Fires in Napa and Sonoma Counties collectively burned over 110,000 acres, destroyed over 6,800 structures, and resulted in 25 fatalities. The 2018 Carr Fire in Shasta County burned nearly 230,000 acres, destroyed over 1,600 structures, and resulted in 8 fatalities. Finally, the 2018 Camp Fire in Butte County burned over 153,000 acres, destroyed nearly 19,000 structures, and resulted in 85 fatalities. The 2018 wildfire season was the deadliest and most destructive wildfire season on record in California (CAL FIRE 2018a). While these fires burned under extreme conditions, preliminary research indicates that proper planning, including vegetation management, can aid in wildfire resiliency. Vegetation management approaches including ladder fuel reduction via stand thinning, roadside fuel treatments, focusing on removing more flammable vegetation, and prescribed burning, have been identified as an important tool in reducing wildfire hazard and enhancing wildfire resiliency (Sonoma Veg Map 2018). These lessons have been considered in development of this Draft VMP.

The fire hazard condition present in the Oakland Hills necessitates a proactive hazard mitigation approach. This VMP acknowledges the City's responsibility to address fire risk on its properties and recognizes that vegetation management is only one component of an overall broader and multi-faceted approach to address and reduce fire hazards in the Oakland Hills. The Oakland Fire Department (OFD) and other City departments are actively engaged in additional fire hazard reduction efforts through the implementation of other plans and programs that focus on other aspects to fire risk reduction apart from vegetation management. While these various efforts are integrated by the City, this VMP is a stand-alone document owing to its technical nature and the need to conduct specific vegetation focused analyses to provide the vegetation focused recommendations of this Plan. Vegetation management is one tool among many to reduce the fire risk. This Plan focusses on vegetation management on City owned properties as a specific component of the City's overall fire risk reduction strategy.

Development of this VMP shows the City's commitment to this responsibility. Finally, the goals, objectives, and management recommendations in this VMP are consistent with Objective CO-10 and Policy CO-10.1 of the Open Space Conservation and Recreation Element of the City of

Oakland General Plan (City of Oakland 1996), which call for managing vegetation to minimize the risk of catastrophic wildfire.

1.1 Purpose and Vision

All vegetation will burn; however, vegetation can be managed to minimize the potential for ignition, facilitate suppression activities, and reduce the likelihood of extreme fire behavior. Annual expenditures associated with wildfire suppression in California have been steadily growing over the past 20 years, totaling $47.7 million in 1997/1998 (fiscal year) up to $947.4 million in 2017/2018 (CAL FIRE 2018b). Vegetation management has proven to be a cost-effective approach for reducing wildfire hazard. As presented by the Multihazard Mitigation Council (2018), the benefit-cost ratio for WUI wildfire mitigation projects averages 3:1 ($3 dollars saved for every $1 spent).

The biological, ecological, and community resources present in the Plan Area were carefully considered in developing this VMP. The purpose of this VMP is to evaluate the specific wildfire hazard factors in the Plan Area and provide a framework for managing vegetative fuel loads on City-owned properties and along roadways within the City's VHFHSZ, such that wildfire hazard is reduced and negative environmental effects resulting from vegetation management activities are avoided or minimized.

The longer-term vision for this VMP involves implementing this Plan such that the fire risk in the Oakland Hills on City-owned properties is reduced. When implemented, the City will follow the Plan framework and methodology to prioritize vegetation management activities in areas with the highest risks, while also providing emergency egress routes, and maintaining access to parks and open spaces. Implementation of the VMP will require funding and a commitment of resources to undertake the activities and recommendations identified in this Plan. While preliminary cost estimates for the activities recommended in this Plan were developed as part of the VMP process, it is beyond the scope of this current VMP to identify or address the specific funding mechanisms that would be necessary to implement the VMP. The City will work with local park stewards and volunteer groups to coordinate vegetation management activities so that people are informed of the City's activities. The City seeks to avoid and minimize potential negative environmental effects of vegetation management to the greatest extent possible, but also recognizes that vegetation management is essential, and the environmental impacts of a catastrophic wildfire in the Oakland Hills similar to the 1991 Tunnel Fire greatly exceed the small-scale, incremental, measured, and routine vegetation management activities recommended in this Plan. In summary, the longer-term vision for the VMP is to protect public safety and foster a healthy environment in the Plan Area.

While this VMP is intended to be a stand-alone document, the information and recommendations presented herein will be used by OFD in evaluating vegetation management needs on an ongoing basis. This VMP will also be a critical component to the overall fire hazard reduction effort being conducted by OFD in the Oakland Hills. Nothing in this VMP shall be construed to create a duty for OFD to conduct fire inspections beyond what state and local law already require.

1.2 Plan Area Location

For the purposes of this VMP, the Plan Area encompasses City-owned parcels and the areas within 30 feet of the edge of roadsides located within the City's VHFHSZ, as defined in Section 4904.3 of the Oakland Fire Code (Oakland Municipal Code Chapter 15.12). Specifically, the Plan Area includes:

- 419 City-owned parcels, ranging in size from <0.1 acres to 235 acres and totaling 1,924 acres. Parcels have been categorized into the following categories, as described in Section 9.2: urban and residential, canyon areas, ridgetop areas, City park lands and open space, other areas, and medians.
- Roadside areas along 308 miles of road within the City's VHFHSZ, which includes surface and arterial streets, State Routes 13 and 24, and Interstate 580.

The City's VHFHSZ encompasses approximately 11,890 acres and extends along the western slope of the Oakland Hills. The extent of the City's VHFHSZ is presented in Figures 1 and 2, and a detailed description of the Plan Area is presented in Section 2. Table 1 summarizes the sizes and quantities of City-owned parcels in the Plan Area.

Table 1
City-Owned Parcels within the Plan Area

Parcel Category	Quantity	Total Acreage
Urban and Residential	152	51.2
Canyon Areas	89	188.7
Ridgetop Areas	11	130.2
City Park Lands and Open Space	91	1,522.9
Other Areas*	43	24.5
Medians	33	6.1
Total:	**419**	**1,923.6**

* Other Areas are developed City-owned properties in the Plan Area that include fire stations (nos. 6, 7, 21, 25 and 28), structures, City facilities (parking lots, police stations), paved areas, and parks and playgrounds (e.g., Montclair Park). Other Areas are not provided management recommendations in this VMP.

SOURCE: ESRI 2017; City of Oakland 2017

DUDEK

0 5,000 10,000 Feet

FIGURE 1

Regional Map

Revised Draft Vegetation Management Plan - City of Oakland, California

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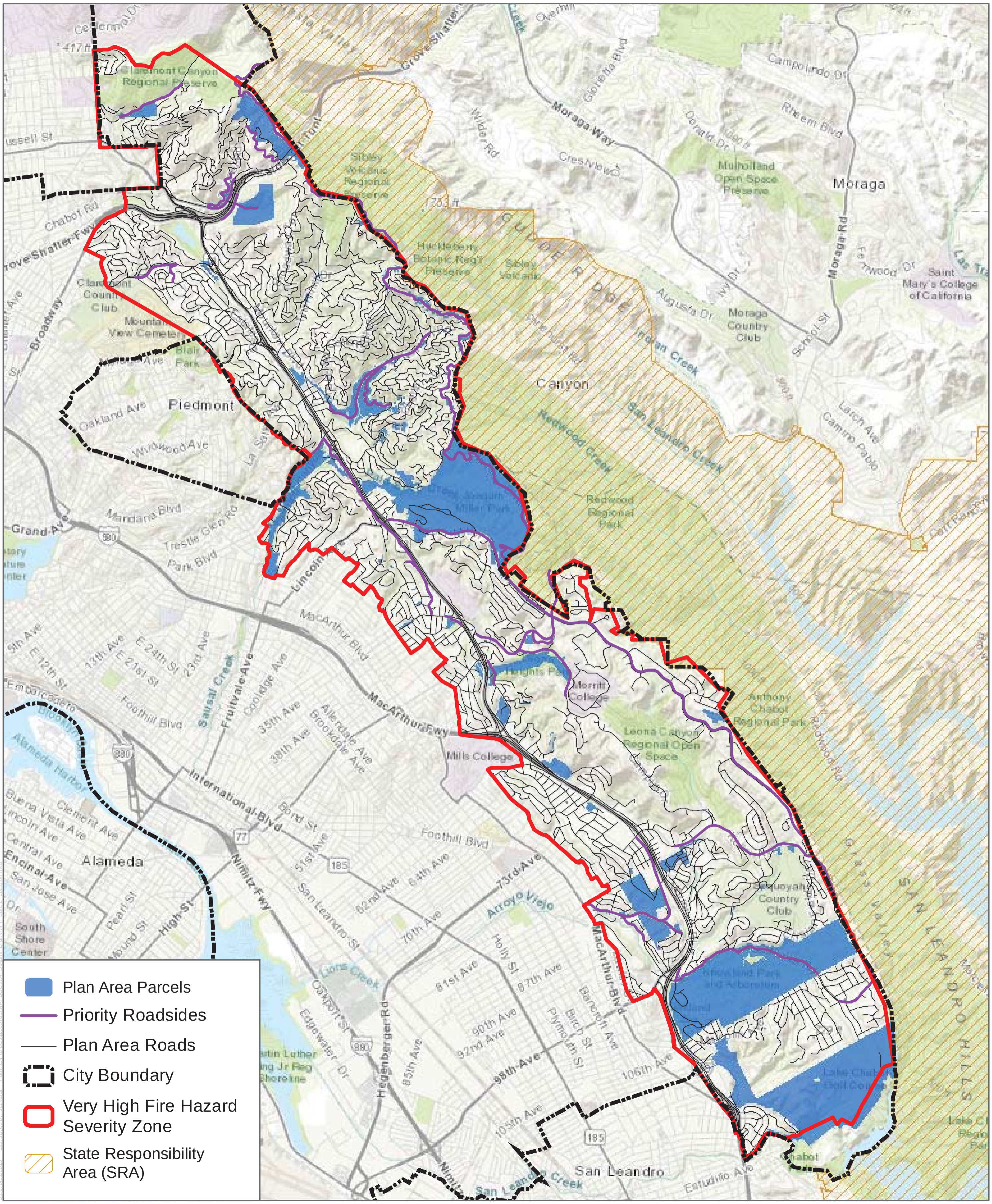

SOURCE: ESRI 2017; City of Oakland 2017; CAL FIRE 2019c

DUDEK

0 2,950 5,900 Feet

FIGURE 2

Location Map

Revised Draft Vegetation Management Plan - City of Oakland, California

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1.3 Plan Scope and Timeframe

The scope of this VMP covers all existing and recommended vegetation management and appurtenant actions occurring on City-owned parcels or along the edge of public roads within the Plan Area. This VMP recognizes that vegetative fuels are one component of wildfire hazard. Vegetation management is a fundamental strategy to reducing fire risk in the Plan Area, and a single component within a multi-faceted approach that is necessary to comprehensively reduce wildfire risk in the Plan Area. Other critical components necessary to reduce wildfire risk include structural hardening through building codes and standards, providing and maintaining suitable access and egress routes, ensuring water availability, firefighter training, and establishment, maintenance, and inspection of defensible space on private properties. OFD and other City departments are addressing these other components of wildfire risk reduction through various plans and programs, including public outreach and fire prevention education and training, roving fire patrols, private property defensible space inspections, and adoption of codes for structures in VHFHSZs. Consequently, this VMP focuses exclusively on vegetation management in the Plan Area and is intended to complement other wildfire risk reduction plans and programs being planned or implemented by OFD and other City departments. Readers and stakeholders are directed to the City's other plans and programs to address other aspects of wildfire risk reduction in the Plan Area. The purpose and focus of this VMP is vegetation management.

The timeframe for this VMP is 10 years. The goals, objectives, methods, and recommendations contained herein should be reviewed at the end of the 10-year timeframe, following a re-evaluation of Plan Area's wildfire hazard conditions and the success of vegetation management actions implemented over the 10-year VMP timeframe. Following such a subsequent review, revisions to VMP goals, objectives, methods, or recommendations may be necessary to reflect wildfire hazard conditions within the Plan Area at a later time.

1.4 Vegetation Management Goals and Objectives

The OFD has identified four primary goals to guide preparation of this VMP and subsequent vegetation management actions implemented to follow this VMP intended to reduce wildfire hazard. The VMP goals provide a framework under which more specific management objectives and recommendations were developed, as presented in this VMP. The goals of the VMP are as follows:

- Reduce wildfire hazard on City-owned land and along critical access/egress routes within the City's designated VHFHSZ;
- Reduce the likelihood of ignitions and extreme fire behavior to enhance public and firefighter safety;
- Implement practices to avoid or minimize impacts to natural resources;

- Maintain an active role in regional efforts to reduce wildfire hazard in the Oakland Hills.

To achieve these vegetation management goals for the Plan Area and over the VMP timeframe, objectives were developed to achieve desired levels of wildfire hazard reduction, public and firefighter safety, and resource protection. The purpose of the objectives is to enable the OFD to make informed, adaptive decisions according to site-specific conditions and prepare annual vegetation management action plans that meet VMP goals over time. The objectives of the VMP are as follows:

- Reduce the likelihood of catastrophic wildfires by limiting ignition potential, reducing fuel loads, and modifying fuel arrangements on City-owned lands.
- Reduce the likelihood of extreme fire behavior within the Plan Area.
- Identify and define vegetation management actions that consider site-specific vegetation type, fuel hazard, treatment effectiveness, and ongoing maintenance requirements.
- Identify and prioritize fuel treatment areas based on fuel loads and arrangements, terrain, topographic exposure, and proximity to roads and structures.
- Retain vegetation where feasible to reduce wind exposure, retain soil and surface fuel moisture, and reduce the potential for soil erosion.
- Develop management recommendations that enable OFD to make informed, adaptive decisions on an annual basis (or more often as necessary) regarding vegetation management within the Plan Area, considering the benefits of treatment, potential environmental effects, and treatment costs.
- Avoid, minimize and/or reduce potential adverse effects of vegetation management on sensitive biological resources, water resources, aesthetics, soils, and slope stability.
- Increase the ability of OFD and other responding agencies to suppress wildfire in the Plan Area in order to minimize wildfire impacts to Plan Area resources.
- Routinely evaluate the effectiveness and implementation frequency of vegetation management actions within the Plan Area.

1.5 Summary of Plan and Hazard Assessment Methodology

Development of this VMP included an assessment of wildfire hazard within the Plan Area and an evaluation of variables that contribute to wildfire risk. The following components comprise the hazard assessment methodology conducted for this VMP:

- **Field Assessments:** Conducted to identify vegetative communities and land cover types, fuel characteristics, fuel models, terrain, and hazard conditions in the Plan Area.
- **Geographic Information Systems (GIS) Analysis:** Conducted to evaluate conditions in the Plan Area, including terrain, vegetative cover, land ownership, City-owned parcel distribution, the area of land within 100 and 300 feet of existing structures, the area of land within 150 feet of park access gates, the area of land within 300 feet of ridgelines, and the extent and distances of Plan Area roads.
- **Fire Behavior Modeling:** Conducted in a GIS for selected larger parcels to identify areas that may be subject to extreme fire behavior, considering weather, fuels, and terrain variables.
- **Research and Community Input:** Research was conducted to document existing vegetation management practices used by OFD and to identify areas subject to high ignition potential. Input from the public on specific fire hazards and high ignition areas was also included. Research was also conducted to evaluate potential costs associated with implementation and maintenance of areas recommended for management under this VMP.

This assessment allowed for the prioritization of vegetation treatment areas within the Plan Area, which was based on several factors, including proximity to structures (e.g., WUI), ridgelines, and access gates, areas along critical access/egress routes, areas subject to increased ignition potential, and areas that exhibit the potential for extreme fire behavior. A more detailed discussion of the methodology is presented in Section 3.

1.6 Volunteer and Stewardship Groups

Volunteer and stewardship groups have been active participants in vegetation management activities in the Plan Area for many years. This VMP recognizes their important role in vegetation management in the Plan Area, and their role is described in detail in Section 11.2.

1.7 How to Use This VMP

This VMP is structured to provide descriptions of vegetation management techniques, standards for vegetation management, and specific projects for implementation of these standards.

This Plan can be read in a linear fashion, from beginning to end. However, the user of this Plan will find that they will have to actively cross-reference between the sections of the Plan to better understand site-specific recommendations.

Sections 2 and 3 provide a description of the Plan Area and the methodology for the wildfire hazard assessment, respectively. Section 4 describes existing codes and standards relevant to vegetation management activity in the Plan Area or the City's VHFHSZ. Section 5 describes existing land or resource management plans and programs relevant to vegetation management activity in the Plan Area or the City's VHFHSZ, which were consulted during VMP development. Section 6 describe the public and stakeholder engagement effort conducted during Plan development and revision. Section 7 summarizes biological, ecological, and community resources found in the Plan Area.

Description of vegetation management techniques is provided in Section 8, along with best management practices for each technique. For example, hand labor techniques will include line trimming, branch pruning/removal, and hand pulling. Best management practices for hand labor techniques include proper training in equipment use, pruning according to International Society of Arboriculture and American National Standards Institute A300 standards, and protecting retained trees and vegetation from tool and equipment damage.

Section 9 outlines vegetation management and maintenance standards, specific recommendations for key areas, and the procedures for identifying and planning annual vegetation treatment operations. Section 9.1 covers management and maintenance standards by dominant vegetation type. For example, maintenance standards for grassland/herbaceous vegetation (grasses; other light, flashy fuels; and surface fuels capable of igniting and carrying fire) are intended to reduce vegetation height (e.g., mowing, grazing) resulting in a shorter and more compact surface fuel layer that is less ignitable and less likely to sustain fire spread. Standards for grassland/herbaceous vegetation include treatment to heights not to exceed 3 inches within 30 feet of a habitable structure. Beyond 30 feet from a habitable structure, grasses, weeds, and thistles shall be treated such that heights do not exceed 18 inches, but it is recommended to cut grasses below 6 inches in height.

Section 9.2 describes current vegetation management practices, and specific recommendations for key areas based on site-specific conditions. For example, current vegetation management in Joaquin Miller Park includes treatment of roadside areas and goat grazing in grassland and disturbed areas. Specific high priority Plan recommendations for Joaquin Miller Park include management of vegetation within 100 feet of structures, within 300 feet of ridgelines, within 150 feet of park access gates, and within 30 feet of known human congregation areas along Skyline Boulevard. If vegetation in these areas is grassland/herbaceous, it would be managed to meet the vegetation management standards outlined above.

Section 9.3 lists the procedures for identifying and planning annual vegetation treatment operations. This includes field assessment of vegetation conditions, treatment timing, treatment prioritization (Priority 1, 2, or 3), and treatment technique selection. This will be captured in annual vegetation management work plans developed by OFD. For example, vegetation management for Joaquin Miller Park identified in the annual work plan would identify vegetation treatment types, area to be treated, implementation timing, resource needs and availability, funding sources, and monitoring and tracking needs.

The vegetation treatment techniques presented in Section 8 are the practices and actions used to modify or remove vegetation, while the vegetation management and maintenance standards presented in Section 9 are the measurable guidelines to achieve the desired vegetation condition to reduce fire hazard. For example, management of grassland in Joaquin Miller Park to the treatment standards outlined above could be accomplished using any of the techniques described in the Plan, such as line trimming, grazing, or mowing.

Section 10 outlines additional best management practices (BMPs) intended to avoid or minimize potential impacts associated with vegetation treatment or removal. For example, as Joaquin Miller Park contains a population of the federally threatened and state endangered species pallid manzanita, measures to protect this species would include identifying locations where this species exists, flagging avoidance areas, and notifying contractors of avoidance areas during the contract bid phase.

Section 11 describes OFD partnerships in reducing fire hazards both on City property and regionally in the Oakland Hills, including other City departments, other large landowners and land managers, and stakeholder and volunteer groups.

Section 12 outlines the methods for implementing the vegetation management recommendations included in this VMP over the 10-year plan timeframe, including annual reporting metrics and documentation for VMP implementation performance.

In summary, Sections 1 through 7 provide important background, context, and setting information to understand the Plan activities. Sections 8 through 12 provide the more specific actions and recommendations of the Plan. Sections 8 through 12 generally require an iterative approach when considering what vegetation management actions to take, including selecting practices (Section 8), determining the criteria or guidelines to implementing those practices most effectively (Section 9), identifying applicable BMPs (Section 10), planning and coordinating with other partners (Section 11), and considering the steps to implement the plan activities (Section 12).

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2 PLAN AREA DESCRIPTION

The fire environment comprises several factors. Fires can occur in any environment where conditions are conducive to ignition and fire movement. The three major components of the fire environment are climate, topography, and vegetation/fuel. The state of each of these components and their interaction with each other determine the potential characteristics and behavior of a wildfire at any given moment. Understanding these existing conditions is necessary to understanding the potential for wildfire within the Plan Area.

Wildfires are a regular and natural occurrence in most of California. However, the numbers of fires and acres burned annually has increased in recent years. These wildfires are mostly human-triggered, suggesting that the historic fire interval has been artificially affected across large areas. In addition, wildfire suppression[1] efforts over the last several decades may have aided in the accumulation of fuels in some natural communities (Minnich 1983; Minnich and Chou 1997) resulting in larger and more intense wildfires. Large wildfires have had, and will continue to have, a substantial and recurring role in California landscapes (Keeley and Fotheringham 2003), in part because (1) California landscapes become highly flammable each fall, (2) the climate in the region has been characterized by fire climatologists as the worst fire climate in the United States (Keeley 2004) with Diablo winds occurring during autumn after a 6-month drought period each year, and (3) ignitions via anthropogenic sources have increased or are increasing in many wildland or WUI areas.

Based on available information and an understanding of the fire environment, it is expected that wildfires will occur again and will burn within the Plan Area. In addition, the Plan Area is classified by the City as a VHFHSZ (Chapter 49, Oakland Fire Code). The Very High Fire Hazard rating is based on a combination of relevant factors of fuel/vegetation, terrain, and climate/weather. Fire Hazard Severity zoning is discussed in more detail in Section 2.5.

2.1 Climate

The climate in the Plan Area is influenced by the maritime locale adjacent to the San Francisco Bay (Bay) and is frequently under the influence of a seasonal, migratory, subtropical high-pressure cell known as the Pacific High (WRCC 2017a). Wet winters and dry summers with mild seasonal changes generally characterize the San Francisco Bay climate. This climate pattern is occasionally

[1] The act of extinguishing a wildfire.

interrupted by heat waves, cold snaps, isolated thunderstorms, fog, or dry easterly (or northeasterly) winds (WRCC 2017a), known locally as “Diablo” winds.[2]

The great majority of precipitation in the Plan Area occurs during the winter months due to the migration of mid-latitude cyclonic storms (fronts) arriving to the California coast. Rainfall amounts generally increase with elevation along the East Bay Hills due to orographic lifting and cooling processes. Although not typically associated with increased fire risk due to the cooler seasonal temperatures and moister conditions, development of strong mid-winter high pressure conditions also results in off-shore Diablo-type winds in the winter season. Winter cold snaps can occur when frigid high latitude or arctic air masses descend to California.

Live fuel moisture content, a measure of the relative mass of water and indicator of ignitability, for most vegetation in the Oakland Hills reaches the driest point in the late summer, or early fall period. Seasonal drying of vegetation produces conditions that can result in fuel-driven wildfires and fire-associated climatic changes. This condition is referred to as a plume-dominated wildfire. Plume-dominated wildfires are fires where the energy produced by the fire in conjunction with atmospheric instability creates significant convective forces and increased wind speeds. Such fires are extremely unpredictable, spread in various directions simultaneously, and exhibit extreme fire behavior. These fires are extremely dangerous and are often large.

The average annual high temperature calculated from January 1948 to June 2016 for the Oakland area is approximately 65.0º Fahrenheit (F), with higher temperatures in summer and early fall (June through September) reaching up to an average of 73.4°F (WRCC 2017b). The average annual low temperature is 50.0°F, and winter low temperatures are routinely between 42°F and 50°F. The average annual precipitation for the area is 18.03 inches, with the most rainfall concentrated in the months of November (2.52 inches), December (3.11 inches), January (3.71 inches), February (2.71 inches), and March (2.57 inches) (WRCC 2017b). Rainfall is much less during summer months of June (0.18 inches), July (0.04 inches), and August (0.05 inches) (WRCC 2017b).

The regional prevailing wind pattern is from the west or northwest, but the presence of the Pacific Ocean causes a diurnal wind pattern known as the land/sea breeze system. During the day, onshore winds are from the west and travel from the Bay, up the hillslopes and canyons, to the ridgetop of the Oakland Hills. At night, gentler offshore winds, derived from cooler air masses moving

[2] Diablo winds are warm, dry winds that flow downslope when stable, high-pressure air is forced across and down the lee slopes of a mountain/hill range (e.g., Oakland Hills). Diablo winds are similar to Santa Ana winds in Southern California.

downslope, are from the east, and travel from the ridgetop, down the hillslopes and canyons, toward the Bay.

During the summer season, the diurnal winds can be slightly stronger than the winds during the winter season due to greater pressure gradient forces. During summer months, pressure differences between the eastern Pacific and interior areas maintains both northwesterly winds over the coastal waters and onshore winds in the Bay Area. These winds, while not as strong as Diablo winds, can contribute to fire hazard when appropriate conditions exist for wildfire ignition and spread. Surface winds can also be influenced locally by topography and slope variations. The varied topography of the Oakland Hills affects wind velocity and patterns. The highest wind velocities are typically associated with downslope, canyon, and Diablo winds.

Summer fog is an important element of the Bay Area and East Bay Hills microclimates. The generation of Bay fog involves a combination of local and regional atmospheric and topographic processes occurring at daily and seasonal cycles. Warming land surfaces in California's Central Valley during the summer season rise and create an on-shore, generally westerly, wind direction along the central California coastline. This wind carries marine air over the cool coastal waters (subject to the southerly California Current). The marine air masses are cooled to saturation, fog is formed, and by advection the fog moves inland, favoring gaps in the coast range where it can penetrate. The summer advective fog season in the Bay Area is most pronounced in June, July, and into August, but such fog may generate earlier in May and also into the later summer and fall weeks of September.

In the Plan Area, such summer fog typically arrives in the late afternoon or evening and persists through the mid to late morning before "burning off," which is essentially evaporation with the morning sun. Summer fog in the Plan Area is an important influence to local atmospheric, plant, and soil moisture (the water balance), and thereby directly influences the component of the fire risk due to climate. In the Plan Area, heavy fog is even known to generate measurable fog drip precipitation, when moisture coalesces along tree leaves, branches, and trunks.

During periods when the low-pressure gradient of the Central Valley ceases or reverses, the atmospheric pressure and wind gradients that drive the great San Francisco Bay "fog machine" described above stop. When this happens, on-shore flows are reversed to off-shore flows, potentially creating strong Diablo winds, with the overall effect that atmospheric, plant, and soil moisture rapidly decreases. This increased aridity in turn increases the fire risk. The reduction in summer fog and increase in local aridity and off-shore Diablo winds is most intense in the later summer and fall weeks of September, October, and early November when the Oakland Hills frequently experience clear skies and warmer temperatures.

The fire season in the Oakland Hills typically starts in September, as the fog recedes earlier in the day and vegetation begins to dry out from regular, dry, offshore winds. The fire season typically ends in November with the onset of winter rainfall, cooler temperatures, and higher relative humidity. Fires are less common between December and August. However, climate change effects are extending fire season throughout the state, and the fire season in the Oakland Hills may ultimately be year-round. The highest fire danger for this area coincides with the period when the Diablo winds are at their strongest.

Diablo wind conditions are a reversal of the prevailing westerly onshore winds that usually occur on a region-wide basis during late summer and early fall. These winds are warm, dry winds that flow from the warmer, drier inland area east, over the crest of the Oakland Hills, and down through canyons to the Bay. As the winds converge through the canyons, their velocities increase. Consequently, peak velocities are highest at the mouths of canyons and dissipate as they spread across valley floors or the Bay. In extreme cases, wind speeds can exceed 60 miles per hour.

Micro-climates, the climate of a small, restricted area, also characterize the Oakland Hills due significant variations in topography. Micro-climates in the area range from low-elevation, wind-sheltered, and damp locations with northerly or easterly aspects (e.g., lower portions of Claremont Canyon, Shepherd Canyon, Sausal Creek), to high-elevation, wind-exposed and dry locations with southerly or westerly aspects (e.g., Grizzly Peak Open Space, North Oakland Regional Sports Field, lots along Skyline Boulevard). Microclimate conditions can greatly affect fire hazard, and should be considered when determining vegetation treatment priorities and implementation timing. Such conditions are often not captured in weather station datasets or recorded in easily referenced weather almanacs, but are usually well known to locals, land managers, and local agency fire personnel.

2.1.1 Climate Change

As noted above in Section 1, California faces a dramatic increase in the number and severity of wildfires with ten of the most destructive fires occurring since 2015 (CAL FIRE 2019a). The state's major study on climate impacts, the Fourth Climate Assessment (Bedsworth et al. 2018), projects that California's wildfire burn area likely will increase by 77 percent by the end of the century. As identified in Governor Newsom's Strike Force report (State of California 2019), the growing risk of catastrophic wildfires has created an imperative for the state to act urgently and swiftly to expand fire prevention efforts.

Climate change is expected to make forests more susceptible to extreme wildfires by altering temperatures (Hayhoe et al. 2004) and the availability and aridity of fuels (Abatzoglou and Williams 2016). Anthropogenic climate change has emerged as a driver of increased forest fire activity, a trend that is expected to continue when fuels are not limiting (Abatzoglou and Williams 2016). All analyses completed for fire occurrence and severity into the future predict more frequent fires, a greater number of fires, and higher fire severity under climate change scenarios (Fried 2004, Lenihan 2008, Westerling et al. 2011, Westerling 2018).

A changing climate, combined with anthropogenic factors, has already contributed to more frequent and severe wildfires in the western United States (Abatzoglou & Williams 2016, Mann et al. 2016, Westerling 2016), with the number of human-caused fires being much higher in more populated regions of the state. Recently, the area burned by wildfires has increased consistent with increasing air temperatures (OEHHA 2018). Increased wildfire risk and severity are vulnerabilities which are anticipated throughout California (Westerling 2018, Krawchuk et al. 2009). Increased fire occurrence and severity under climate change will secondarily affect other areas of vulnerability, as noted below.

- Increased Fire Risk: Warmer air temperatures are expected to lengthen the fire season, drying out vegetation more quickly and increasing fire risk. Based on high- and low-emissions climate change scenarios, increases in the number of high-severity wildfires is anticipated (Westerling 2018). Multi-year severe drought is supported as a factor in increasing fire size and severity, as well as tree mortality (Crockett and Westerling 2018). On inter-annual and shorter time scales, climate variability affects the flammability of live and dead forest vegetation (Westerling 2016).

- Greater Fuel Loads: Years with widespread fires are historically preceded by wet years which influence greater vegetation growth, especially in the understory. Highly flammable species, which often populate disturbed areas quickly, may have a competitive advantage over other species, typically resulting in a higher, more flammable fuel load. Drought may result in increased tree mortality, which contributes to higher fuel loading and wildfire size and severity (Crockett and Westerling 2018). Increasing fire size and severity and tree mortality are linked to increasing temperatures and aridity (Crockett and Westerling 2017). Increased prevalence of dead or desiccated fuels resulting from drought effects is conducive to crown fires, which require ladder fuels to move from volatile grasses to the less volatile mid-level forest to the dry and volatile canopy cover (Crockett and Westerling 2017). Increased fuel aridity contributes to larger forest areas experiencing increased periods of high fire potential (Abatzoglou and Williams 2016).

- Ecological Impacts: Increased fire severity is expected to amplify and accelerate the ecological impacts of climatic change. Drought years may increase the vulnerability of tree populations to insects and disease, and the lower occurrence of extended freezing periods in the winter will allow greater insect survivability. Climate-induced changes in fire behavior and frequency will influence species distribution, migration, and extinction

(Flannigan 2000). Greater occurrence of fires increases the amount of carbon and particulates released into the atmosphere (Westerling 2006).

- Social Impacts: Increased expenditures for fire suppression are anticipated and the amount of burned property (in total area and in monetary value) in Northern California increases substantially under global climate models' high-emissions scenarios due to greater fire risk (Westerling and Bryant 2008, Levy 2018). In areas with the highest fire risk, wildfire insurance is estimated to see costs rise by 18 percent by 2055 and the quantity of properties insured lowered (Westerling 2018). Wildland fire smoke exposure is a growing risk to public health (Domitrovich et al. 2017). Secondary effects of increased fire, such as loss of recreational amenities, area closures, and excessive smoke, can have serious financial effects for regional business interests and local economies.

The management recommendations included in this VMP include strategic and selective fuels management actions to reduce fuel loads, minimize ignitions, and reduce the potential for extreme fire behavior. The management standards for forested areas are intended to reduce overall fuel loads and increase retained tree health and vigor by increasing retained tree spacing. Increased tree spacing would result in less competition for resources (such as water and soil nutrients). Reduced fuel loads would modify potential fire behavior, reducing heat output and the potential for crown fires and fire-related tree mortality. This VMP anticipates an increase in wildfire potential due to climate change, and seeks to manage fuels such that wildfire impacts are reduced.

2.2 Topography

The Oakland Hills area is located in the steep coastal mountains to the east of the San Francisco Bay known as the East Bay Hills. The hillslopes and canyons meet the Bay plain to the west and slope upward to the northwest–southeast-oriented ridgeline to the east. The lowest elevations in the City's VHFHSZ are approximately 70 feet above mean sea level at the bottoms of Arroyo Viejo and San Leandro Creek (USGS 2013a, 2013b). The highest elevations are in the northern portion of the City's VHFHSZ (approximately 1,500 feet above mean sea level near Grizzly Peak (USGS 2013a, 2013b).

The City's VHFHSZ is characterized by multiple drainages that run generally east to west, or northeast to southwest, downward from the summit ridgeline that roughly parallels Grizzly Peak Boulevard and Skyline Drive. Listed in general north to south order, prominent watersheds and drainages include Claremont Canyon, Temescal Creek, Shepherd Creek, Palo Seco Creek, Sausal Creek, Horseshoe Creek, Rifle Range Branch (Creek), Country Club Creek, Arroyo Viejo, Grass Valley Creek, and San Leandro Creek. The creeks in the City's VHFHSZ generally converge into a few larger creeks in the lower Bay plain region, ultimately reaching the San Francisco Bay. The steepest slopes in the City's VHFHSZ have gradients up to 62 degrees (186%), although the majority of the area has slope gradients of less than 27 degrees (50%), and the mean slope gradient for the area is 16 degrees (29%) (USGS 2013a, 2013b).

All slope aspects are represented in the City's VHFHSZ, with a higher proportion of south-, southwest-, and west-facing slopes present. The effect of aspect on fire hazard is related to solar exposure. South and west-facing slopes are subject to more thermal heating from the sun and consequently have higher temperatures and lower fuel moistures. These slope aspects are typically dominated by lighter fuels (brush, grasses). North- and east-facing slopes receive less solar exposure and are therefore cooler and typically have heavier fuel loads (trees).

Topography affects wildfire movement and spread. Steep terrain typically results in faster upslope fire spread due to pre-heating of uphill vegetation. Flat areas typically result in slower fire spread, absent of windy conditions. Topographic features such as saddles, canyons, and chimneys (land formations that collect and funnel heated air upward along a slope) may form unique circulation conditions that concentrate winds and funnel or accelerate fire spread. For example, fire generally moves slower downslope than upslope. Terrain may also buffer, shelter, or redirect winds away from some areas based on canyons or formations on the landscape. Saddles occurring at the top of drainages or ridgelines may facilitate the migration of wildfire from one canyon to the next.

The narrow drainage and sub-drainage topographic features of the Oakland Hills have the capability to funnel winds, increase wind speeds, erratically alter wind direction, and facilitate fire spread and promote extreme fire behavior. This is especially true during Diablo wind events, when strong easterly or northeasterly winds are aligned with the downslope direction of the canyons and watersheds of the Oakland Hills. The topography of the Oakland Hills is therefore capable of producing wind conditions that promote extreme wildfire behavior.

Various terrain features can also influence fire behavior, as summarized in Table 2. Plan Area terrain is graphically presented in Figures 3.1 through 3.10.

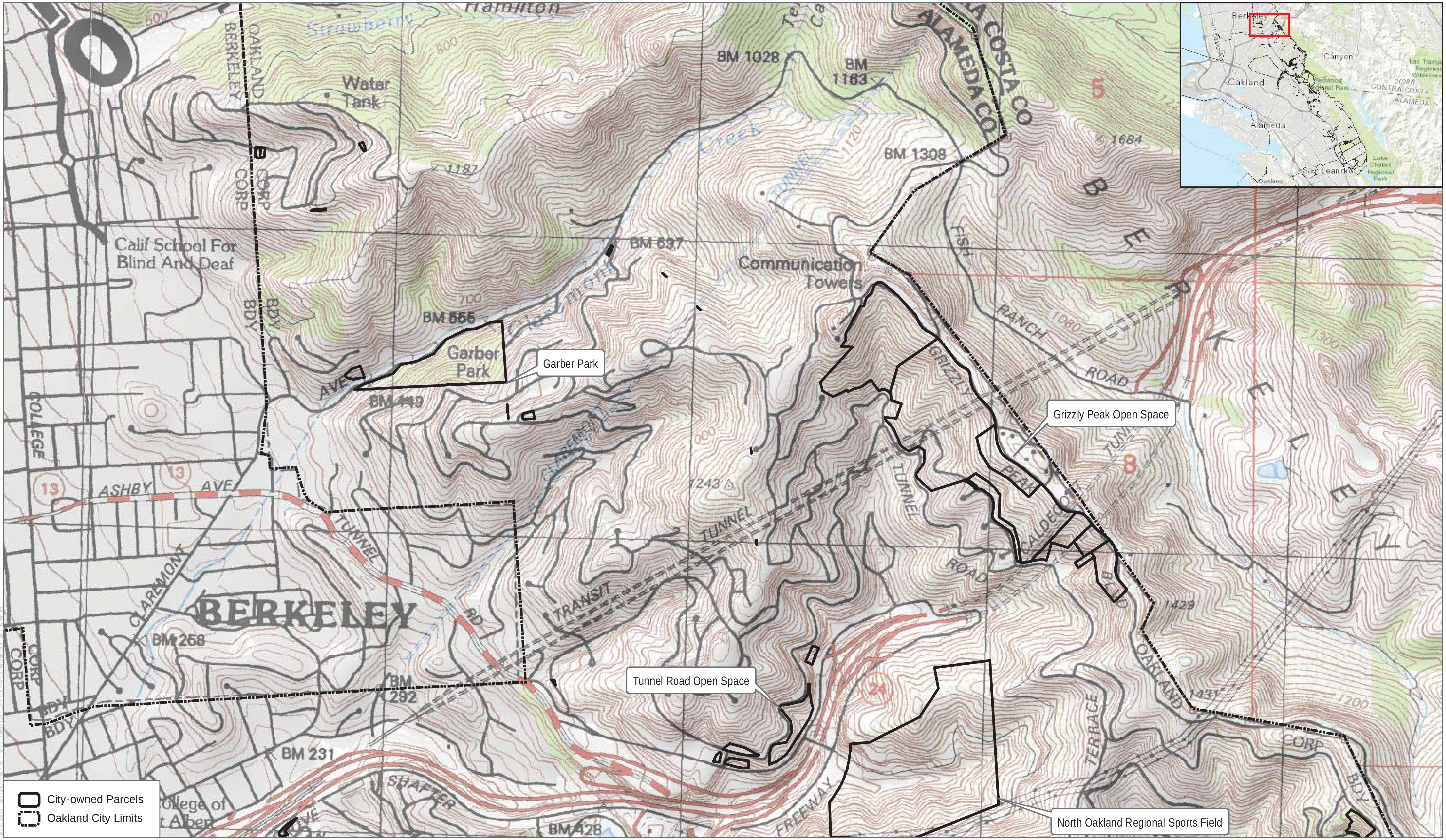
Table 2
Effects of Topographic Features on Fire Behavior

Topographic Feature	Effect
Narrow Canyon	Surface winds follow canyon direction, which may differ from prevailing wind; wind eddies/strong upslope air movement expected, which may cause erratic fire behavior; radiant heat transfer between slopes facilitates spotting/ignition on opposite canyon side.
Wide Canyon	Prevailing wind direction not significantly altered; aspect significant contributor to fire behavior. Wide canyons not as susceptible to cross-canyon spotting except in high winds.

Table 2
Effects of Topographic Features on Fire Behavior

Topographic Feature	Effect
Box Canyon/Chute	Air drawn in from canyon bottom; strong upslope drafts. No gaps or prominent saddles to let heated air escape. Fires starting at canyon bottom can move upslope very rapidly due to a chimney-like preheating of the higher-level fuels and upslope winds.
Ridge	Fires may change direction when reaching ridge/canyon edge; strong air flows likely at ridge point; possibility for different wind directions on different sides of ridge. Ridges experience more wind. Fires gain speed and intensity moving toward a ridge. Fires burning at a ridge can exhibit erratic fire behavior. Strong air flows can cause a whirling motion by the fire. As the wind crosses a ridge it usually has a leeward eddy where the wind rolls around and comes up the leeward side.
Saddle	Potential for rapid rates of fire spread; fires pushed through saddles faster during upslope runs. Winds can increase when blowing through saddles due to the funneling effect of the constricted pass. On the other side, winds will slow, but erratic winds potentially occur at the saddle due to eddies.

Sources: Teie 1994; Firewise 2013.



SOURCE: USGS 2017; ESRI 2017; Oakland 2016

DUDEK

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FIGURE 3.1

Plan Area Terrain

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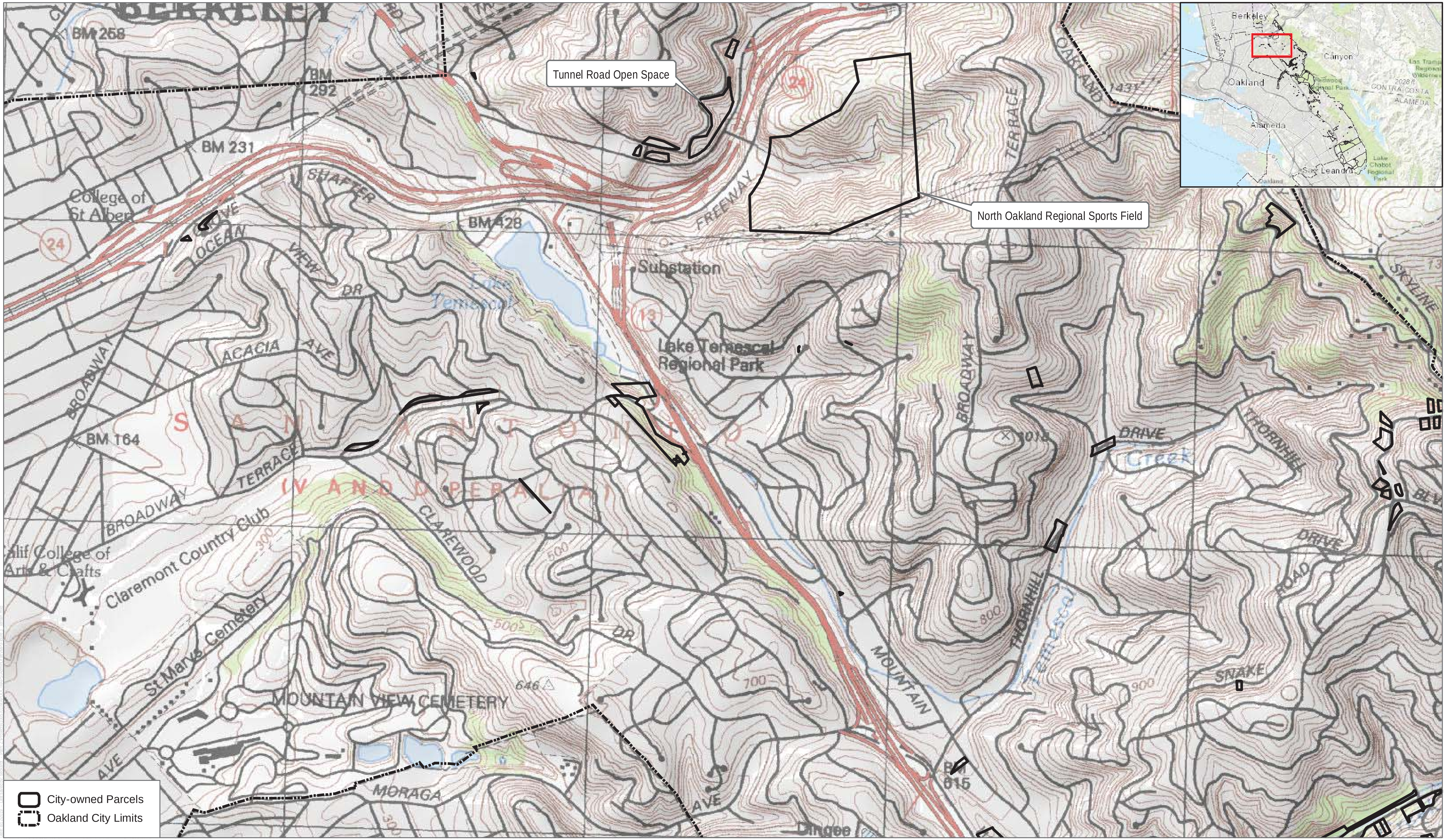

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 3.2

Plan Area Terrain

Revised Draft Vegetation Management Plan - City of Oakland, California

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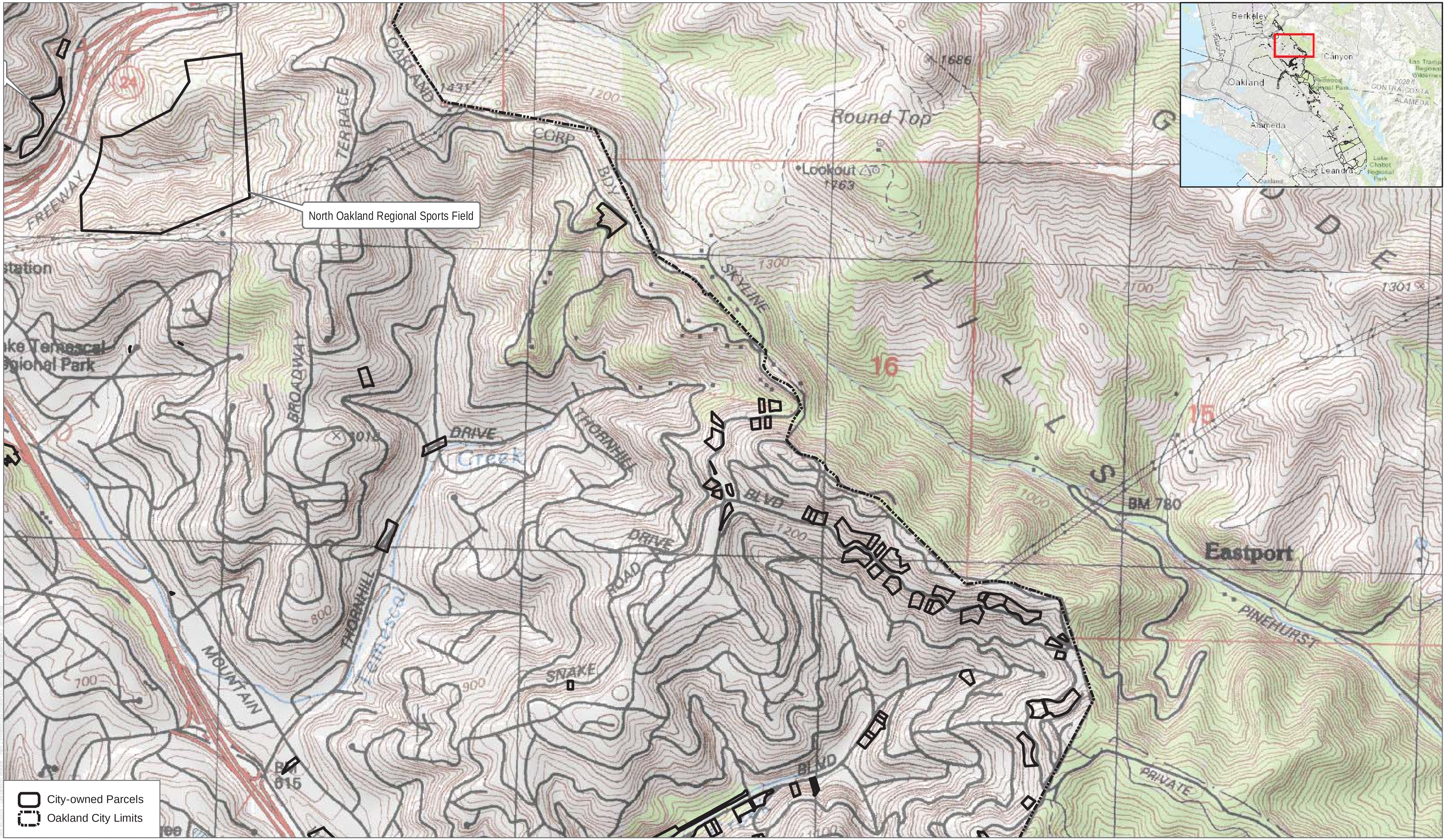

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 3.3

Plan Area Terrain

Revised Draft Vegetation Management Plan - City of Oakland, California

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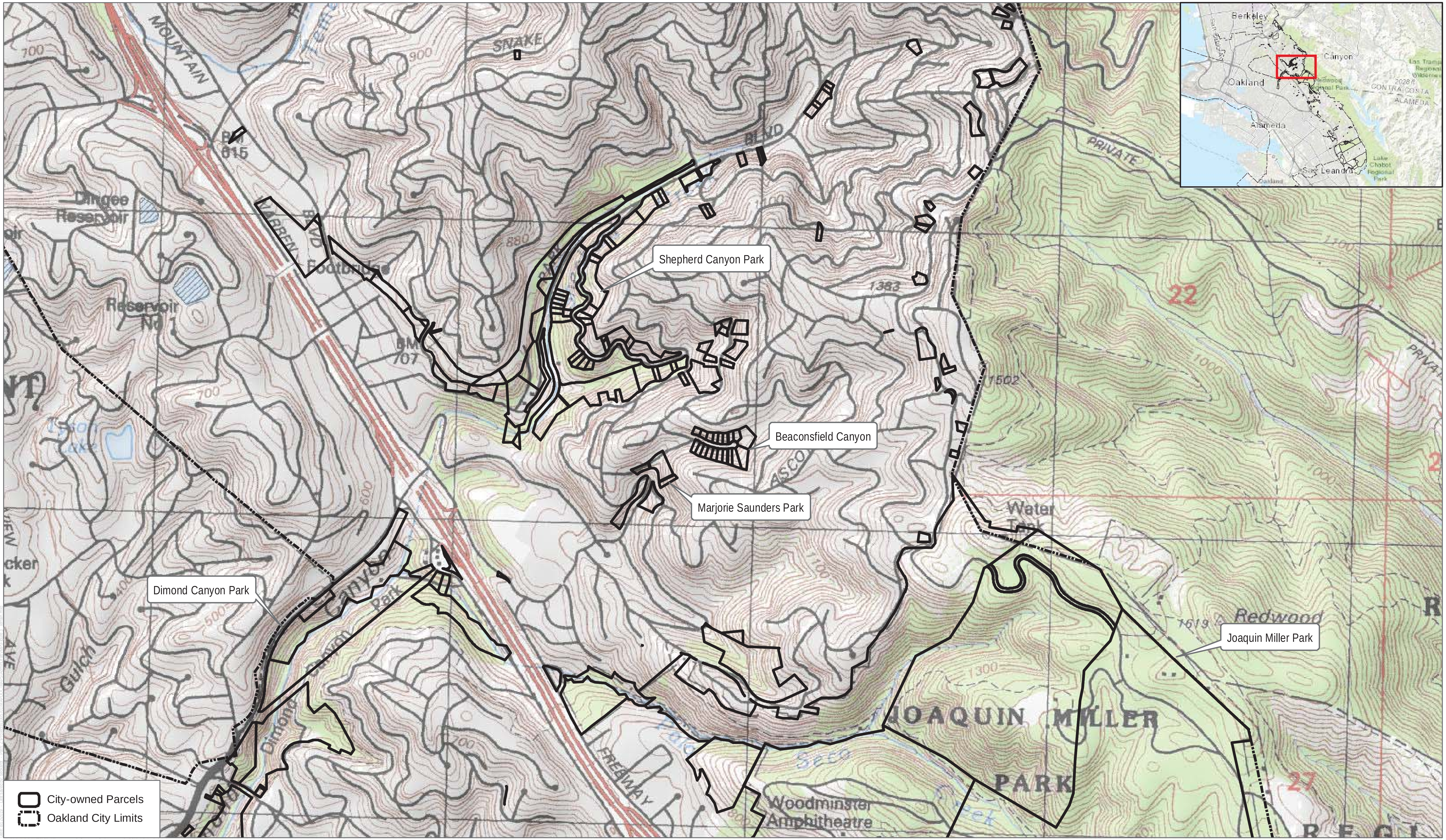

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 3.4

Plan Area Terrain

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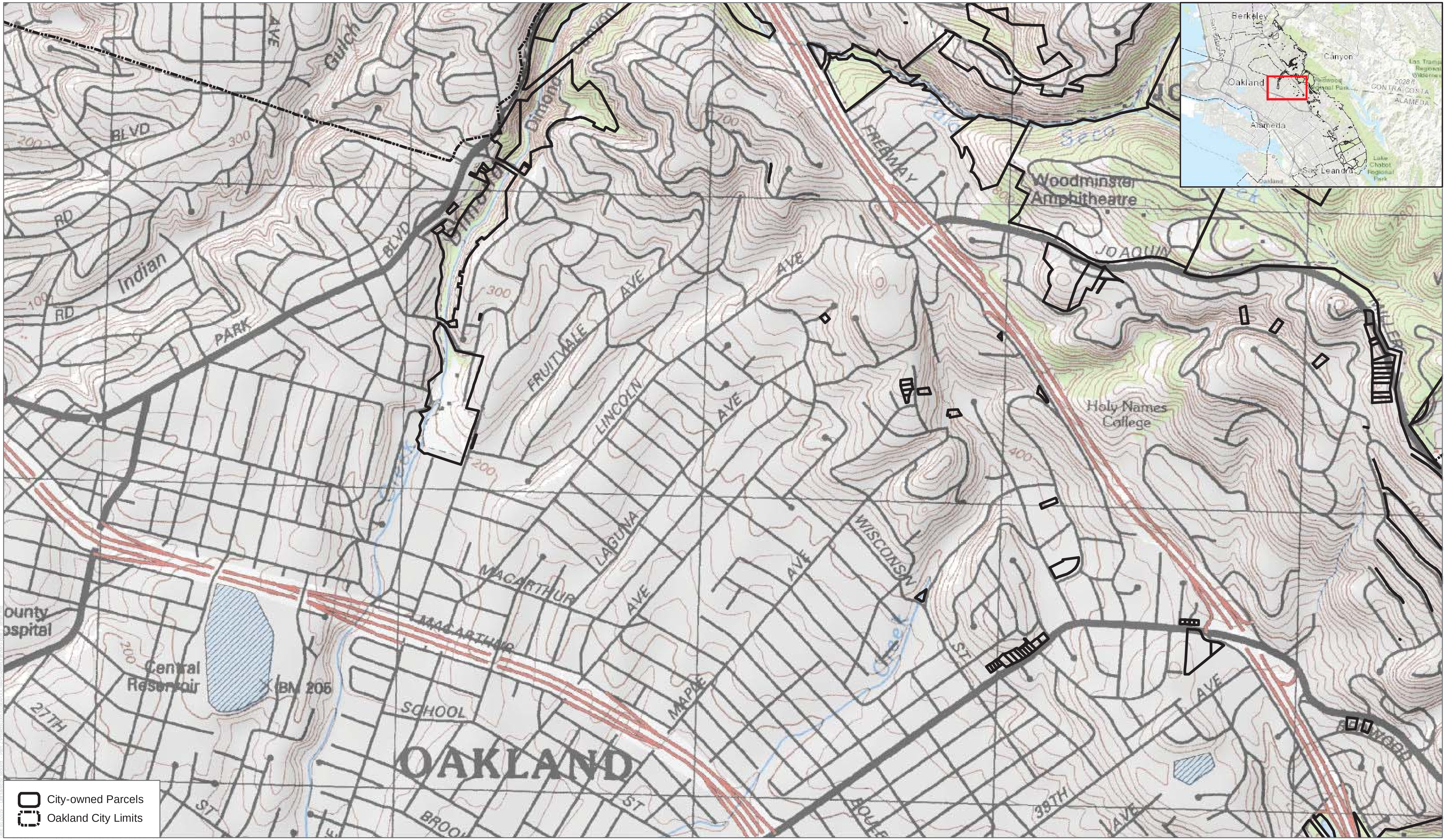

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 3.5

Plan Area Terrain

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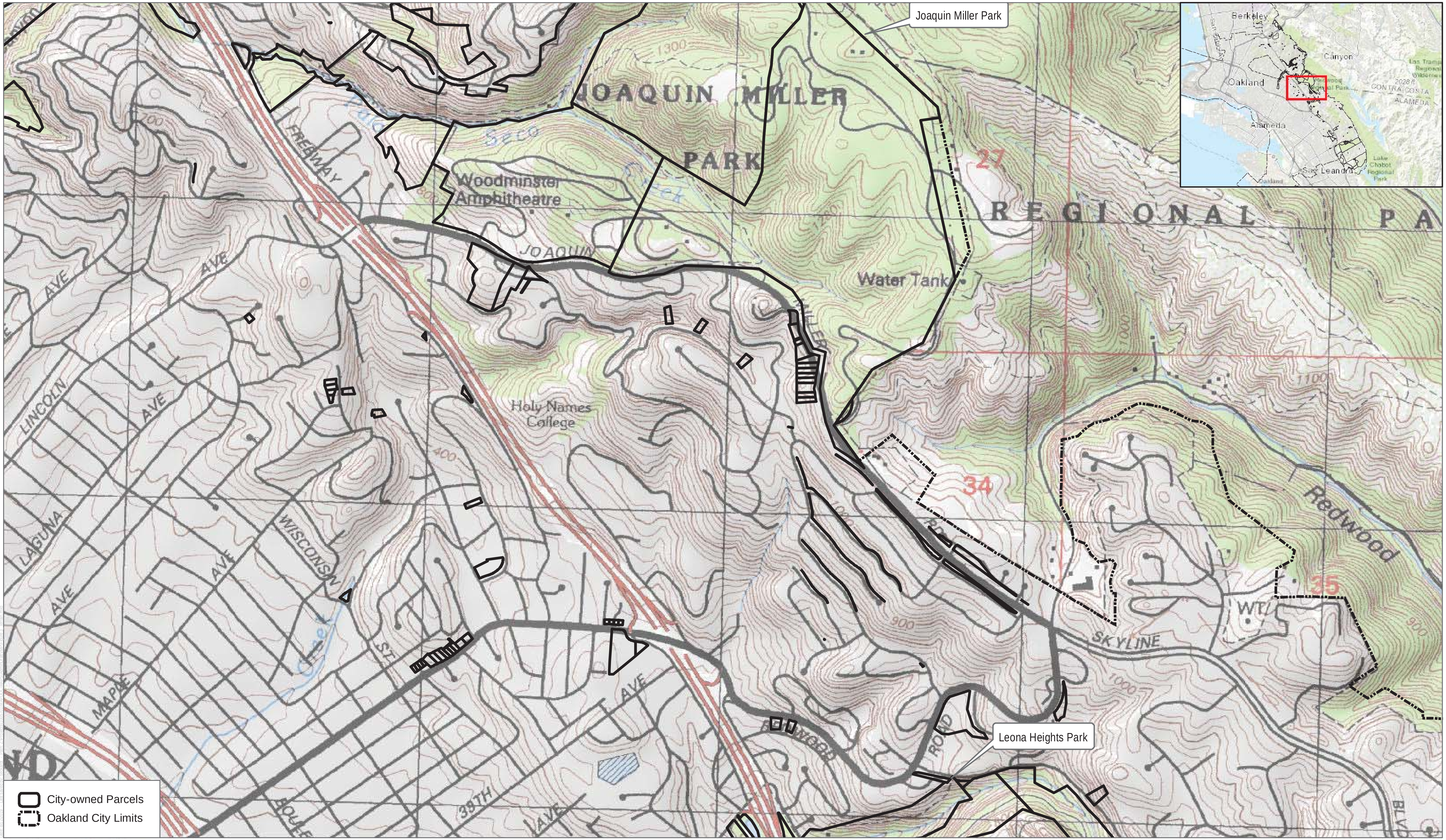

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

FIGURE 3.6

Plan Area Terrain

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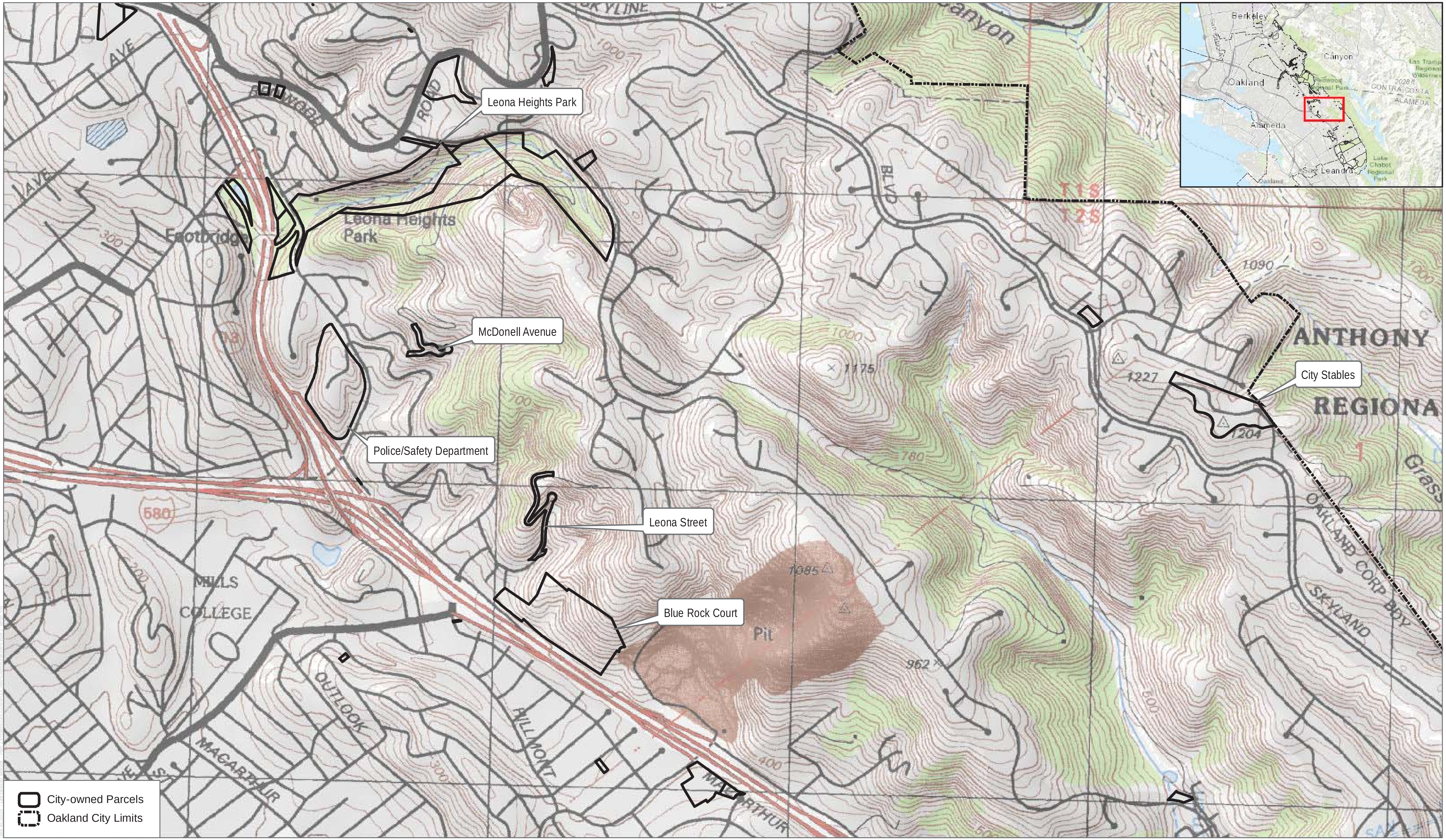

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 3.7

Plan Area Terrain

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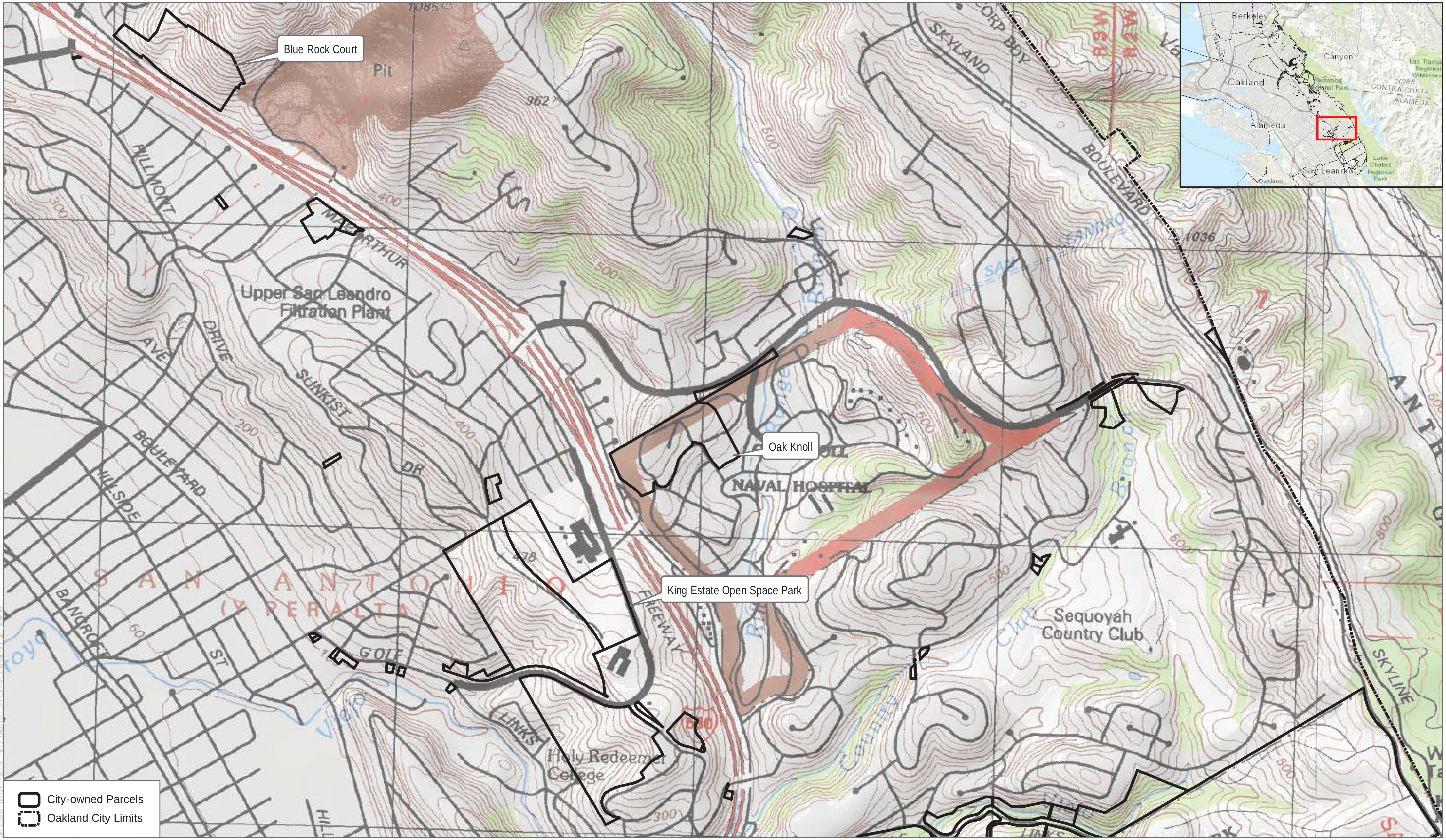

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 3.8

Plan Area Terrain

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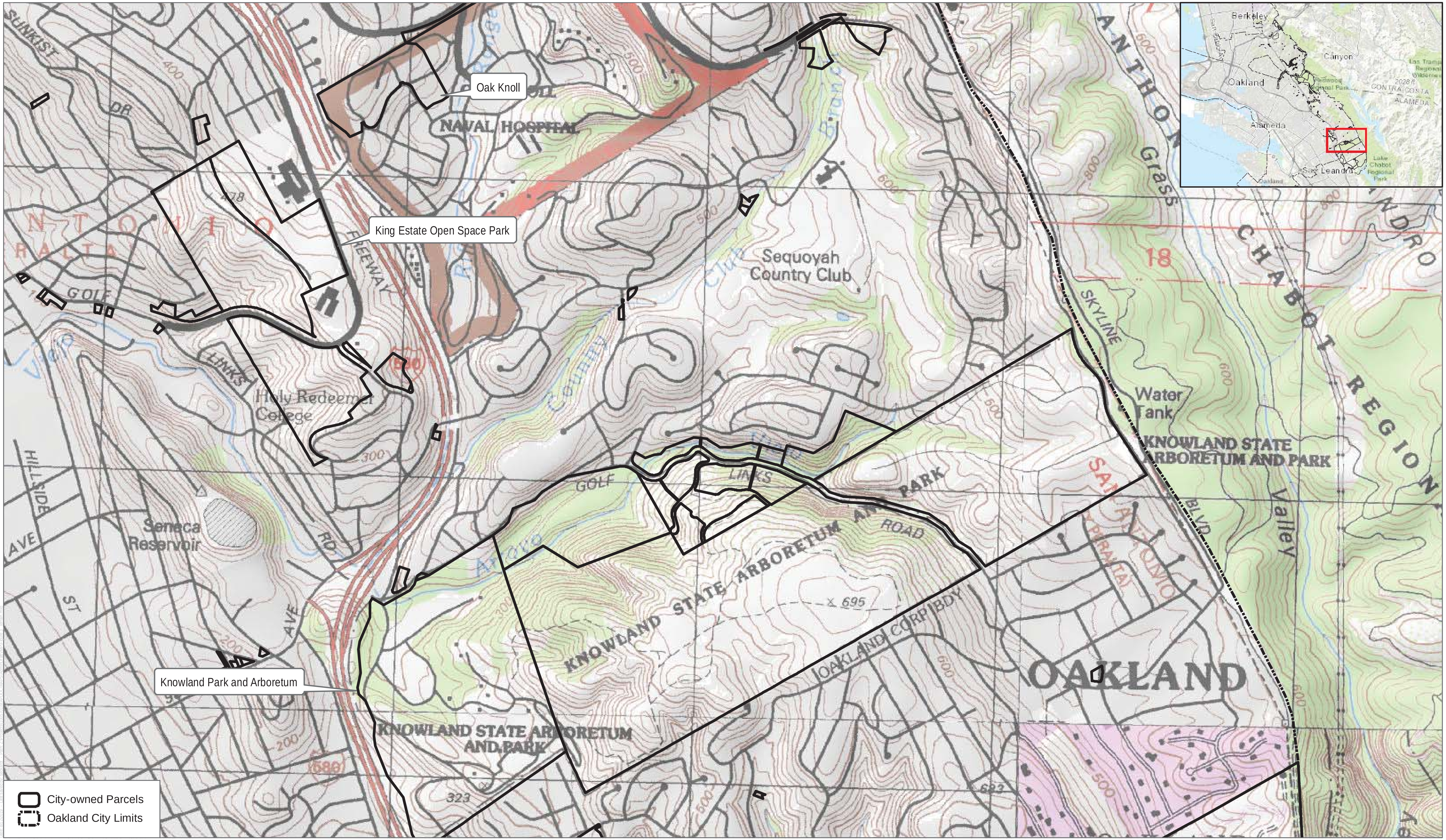

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 3.9

Plan Area Terrain

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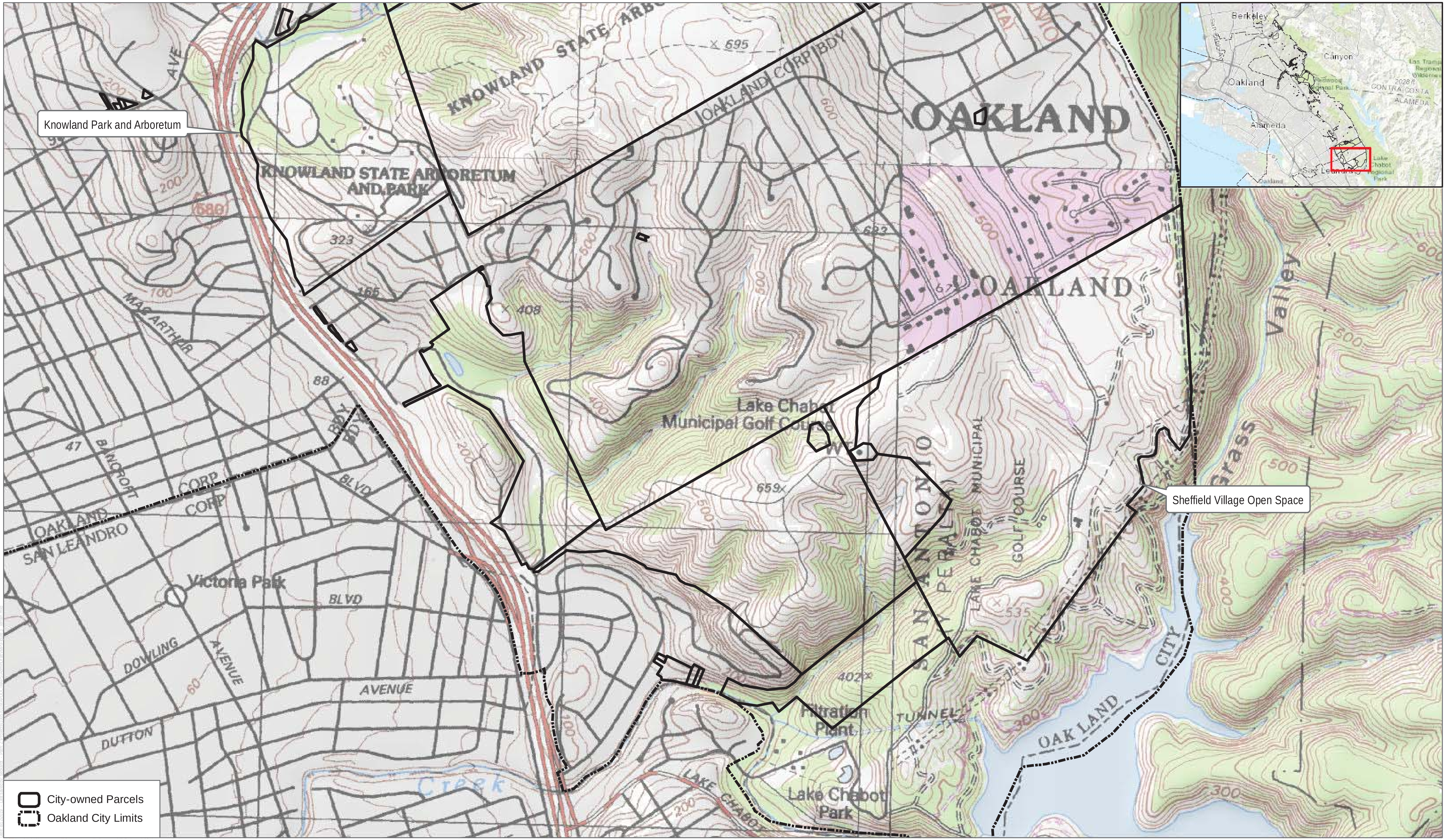

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 3.10

Plan Area Terrain

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2.3 Vegetation and Fuels

This section summarizes the vegetation types (fuels) present in the Plan Area and their contribution to fire hazard. Hazardous fuels include live and dead vegetation that exists in a condition, which readily ignites; transmits fire to adjacent structures or ground, surface, or overstory vegetation; and/or is capable of supporting extreme fire behavior.

2.3.1 Field Assessments

Field assessments were conducted by Horizon Water and Environment (Horizon) to map and classify the existing vegetation communities and land cover types present in the Plan Area. Vegetation and land cover was classified using the California Wildlife Habitat Relationship (WHR) System. Vegetation and land cover types in the Plan Area include coast oak woodland, redwood, valley/foothill riparian, closed-cone pine-cypress, eucalyptus, coastal scrub, mixed chaparral, freshwater emergent wetland, perennial grassland, annual grassland, and urban land covers (Appendix B). The Biological Resources Report prepared for the Plan also identifies areas of high biological resource value within the Plan Area and is included in Appendix B. Table 3 summarizes the different vegetation communities and land covers identified and mapped in the Plan Area, and Figures 4.1 through 4.10 presents the distribution of vegetation communities and land covers across the Plan Area.

Table 3
Vegetation Communities and Associated Fuel Models in the Plan Area

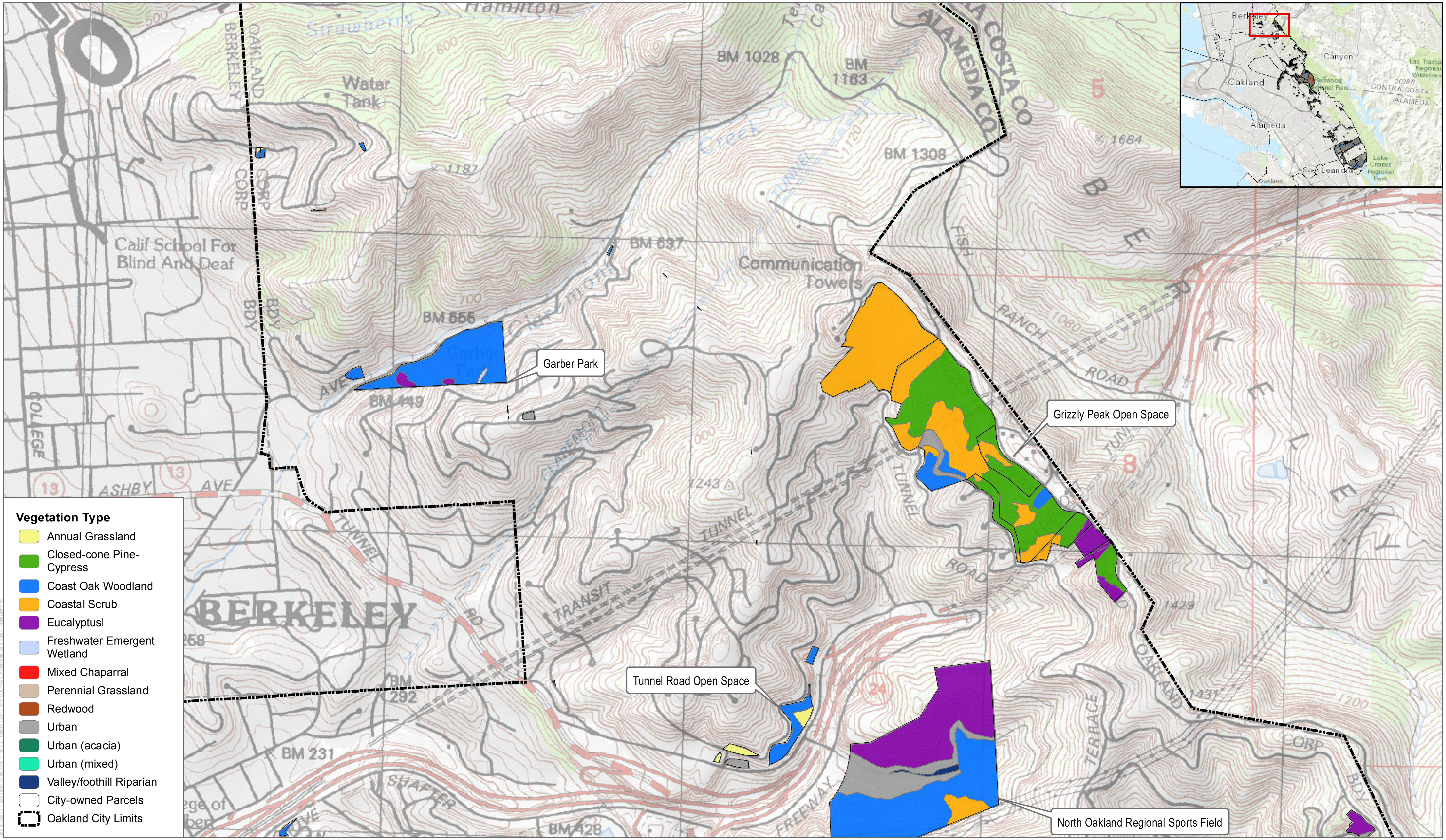
Vegetation Community/Land Cover	Fuel Models*	Acres	Percentage
Annual Grassland	GR1, GR4	250.7	13.03%
Closed-Cone Pine-Cypress	SH5, TU1, TU5, TL2, TL3, TL6	164.3	8.54%
Coast Oak Woodland	GR1, GS2, TU1, TL2	585.6	30.44%
Coastal Scrub	GR1, GS2, SH1, SH5	170.7	8.87%
Eucalyptus	GR1, SH5, TU1, TU5, TL2, TL3, TL6, TL9	176.5	9.17%
Freshwater Emergent Wetland	NB1	0.4	0.02%
Mixed Chaparral	SH5	8.1	0.42%
Perennial Grassland	GR1	13.4	0.70%
Redwood	TU1, TL3	140.6	7.31%
Valley/Foothill Riparian	SH1, TU5	1.4	0.07%
Urban (Developed)	GR1, NB1	401.5	20.87%
Urban (Acacia)**	TU1	6.8	0.35%
Urban (Mixed Tree Stand)**	GR1	3.7	0.19%
	Total	**1,923.6*** **	**100.00%**

Notes:
* A discussion of fuel models is presented in Appendix C.
** The Urban WHR classification includes ornamental tree plantings in parks, and those dominated with acacia and mixed trees have been called out separately for this VMP for the purposes of evaluating fire behavior and fire hazard.

***Table 3 values for acreages do not include the roadside buffer areas that are included in Table 1 of Appendix B. The acreage values shown and listed in Appendix B include these areas, resulting in a difference in acreage totals.

Field assessments were also conducted by Dudek to evaluate existing fuel load conditions and understand general fuel hazard conditions and current maintenance practices being conducted by OFD within the Plan Area. Field assessments of fuel conditions were conducted between December 2016 and August 2017. Site conditions were documented via photographs and in some cases noted on digital or hard-copy field maps.

Field assessments were also used to identify and classify vegetation community types into fuel models (Anderson 1982; Scott and Burgan 2005). Fuel model assignments are presented in Table 3 by vegetation community or land cover type. A discussion of fuel models and potential fire behavior is presented in Appendix C. Taken together, the (1) field assessment of existing vegetation and land cover conditions, (2) assessment of fuel load conditions, and (3) identification of how existing vegetation types align with existing fuel studies and models present an empirical on-the-ground (field-based) approach and basis for the treatments and approaches recommended in this VMP.



SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

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FIGURE 4.1

Plan Area Vegetation Distribution

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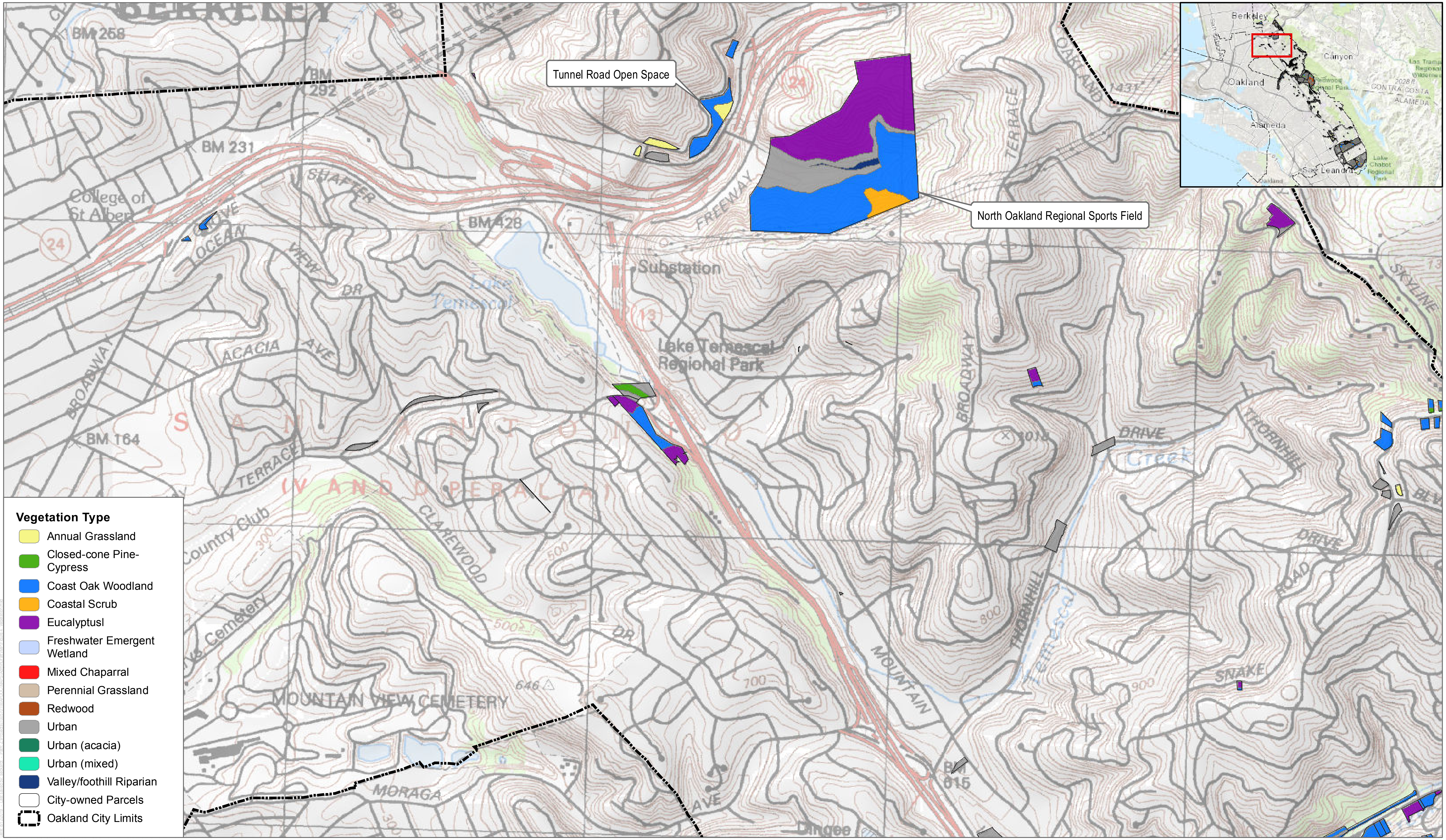

SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

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FIGURE 4.2

Plan Area Vegetation Distribution

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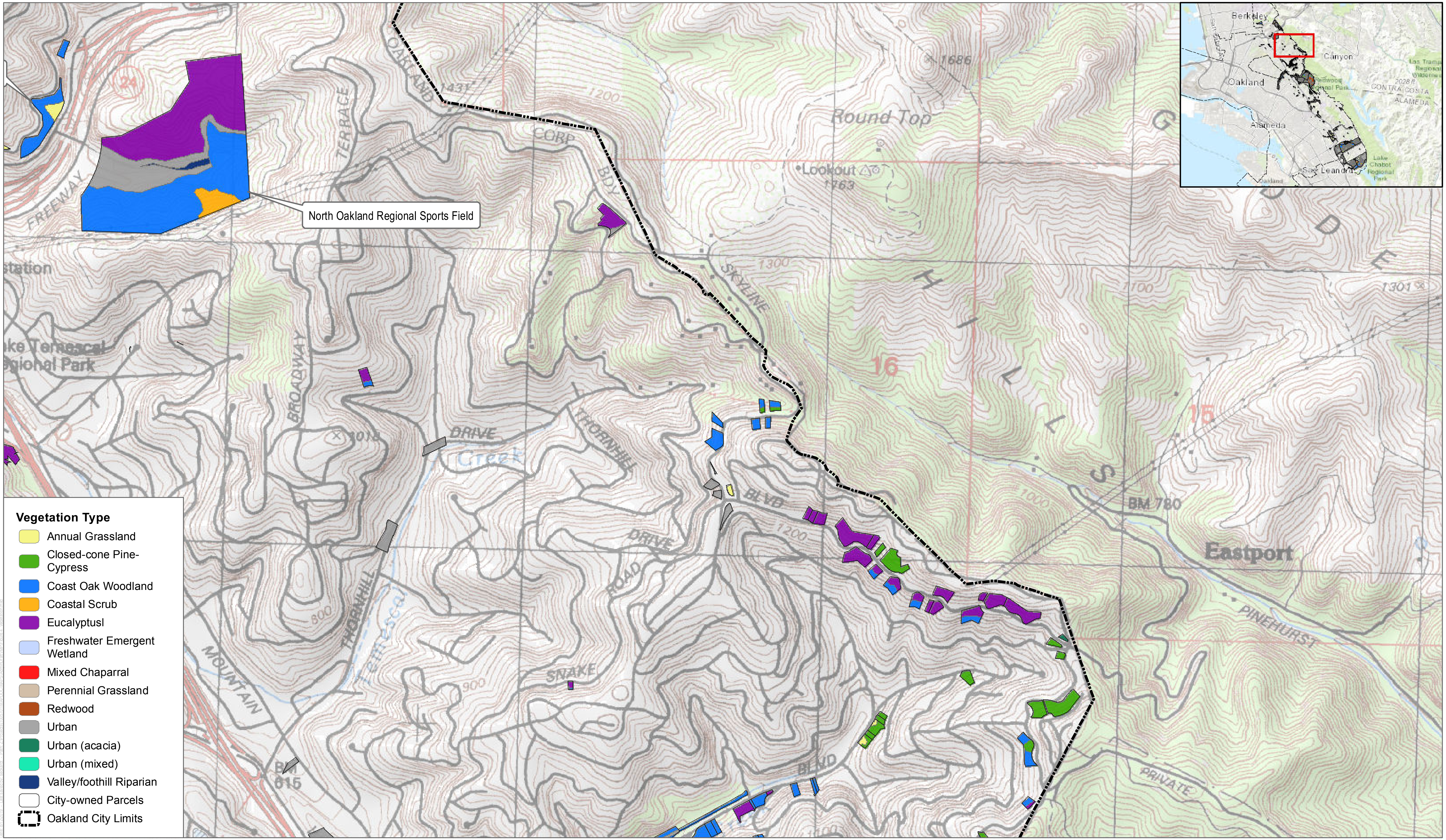

SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

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FIGURE 4.3

Plan Area Vegetation Distribution

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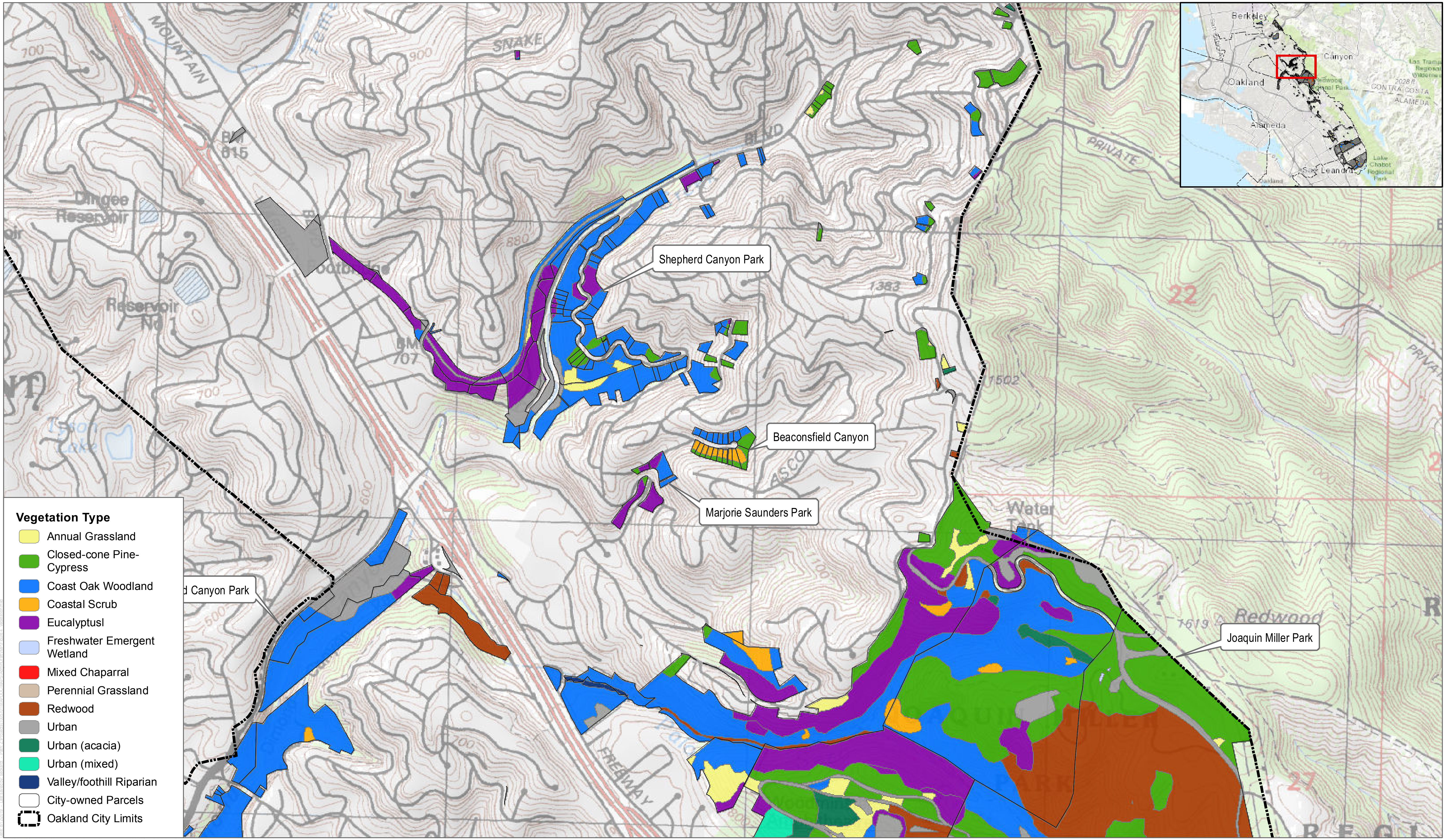

SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

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FIGURE 4.4

Plan Area Vegetation Distribution

Revised Draft Vegetation Management Plan - City of Oakland, California

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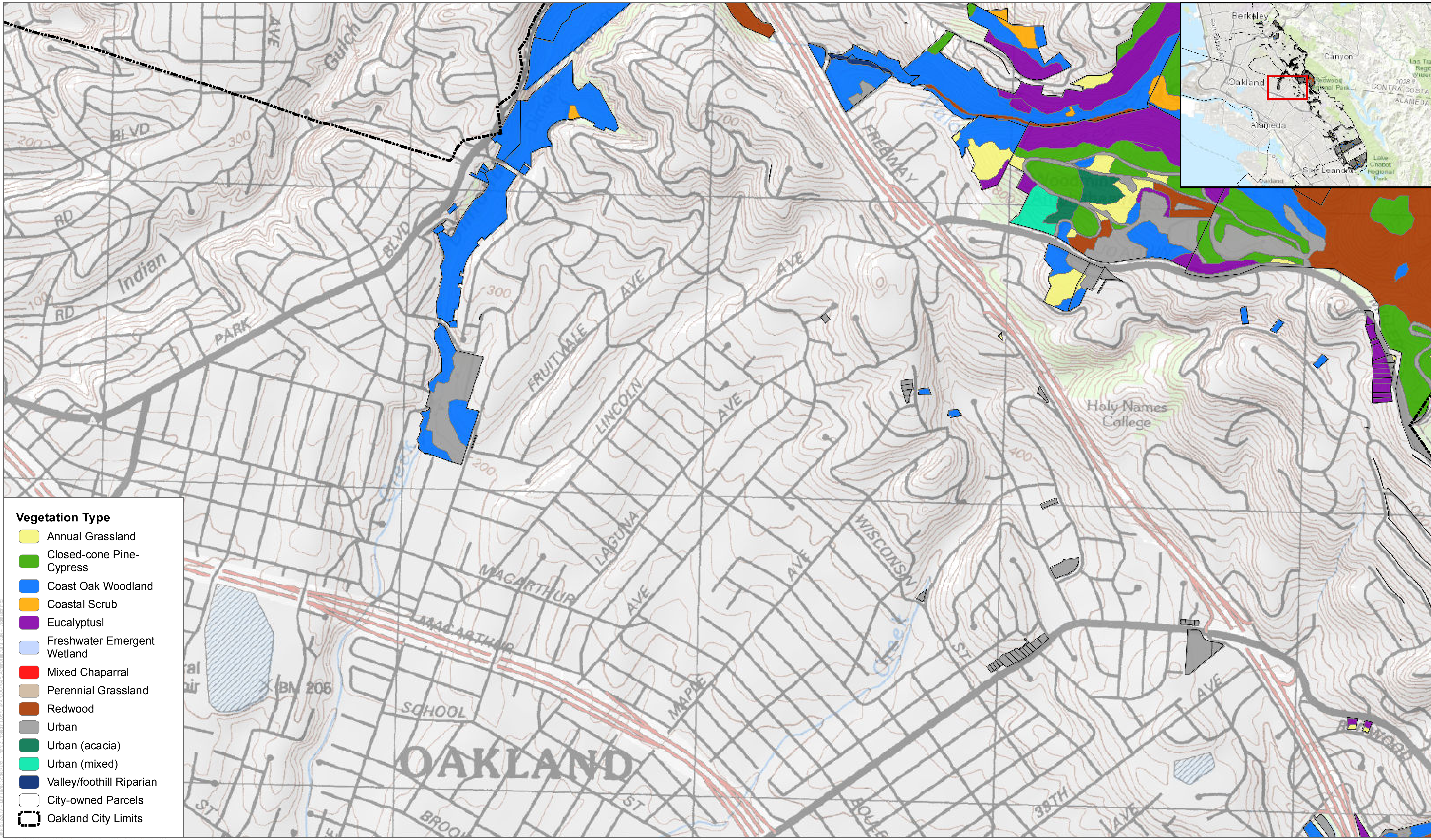

SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

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FIGURE 4.5

Plan Area Vegetation Distribution

Revised Draft Vegetation Management Plan - City of Oakland, California

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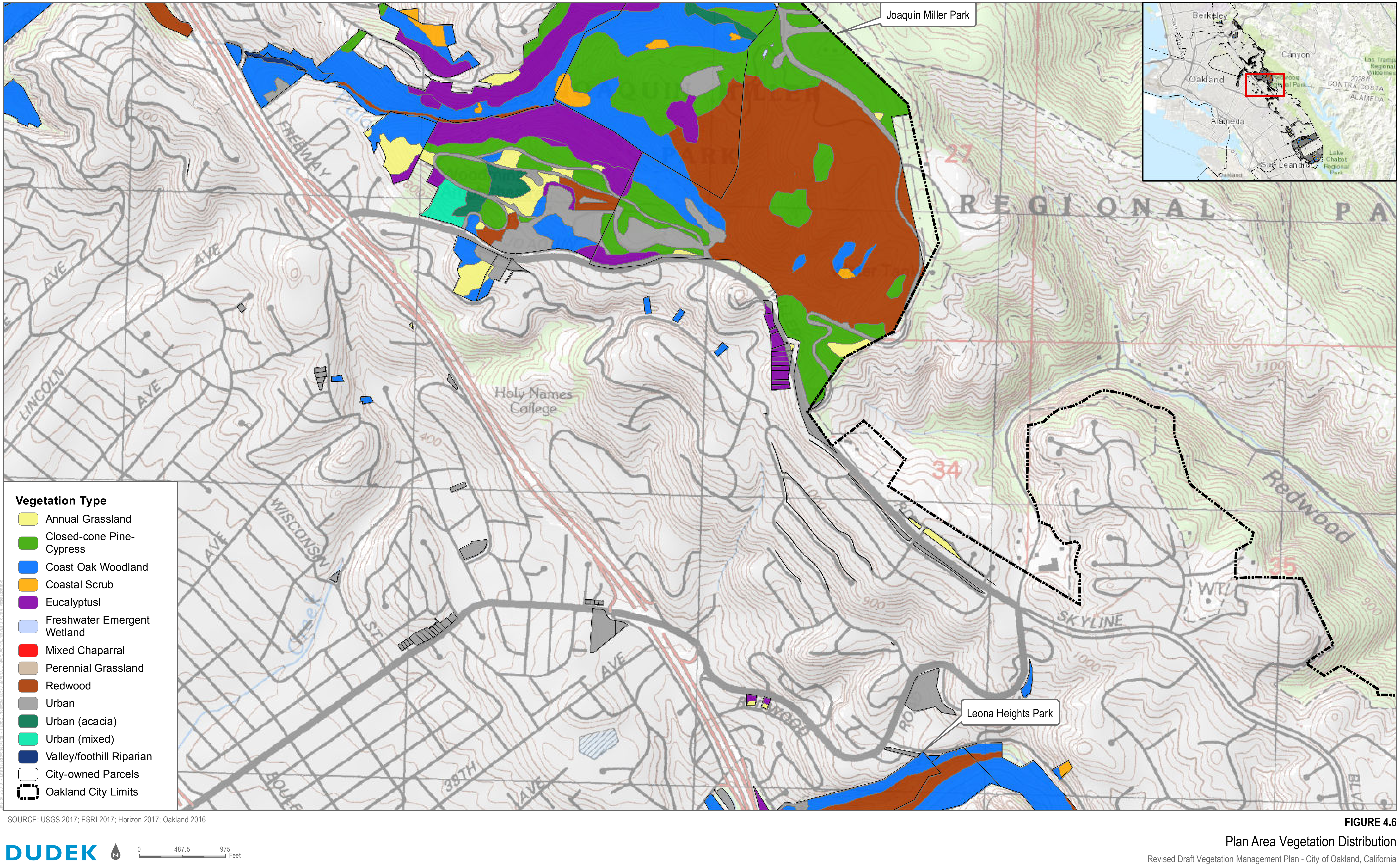

SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

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FIGURE 4.6

Plan Area Vegetation Distribution

Revised Draft Vegetation Management Plan - City of Oakland, California

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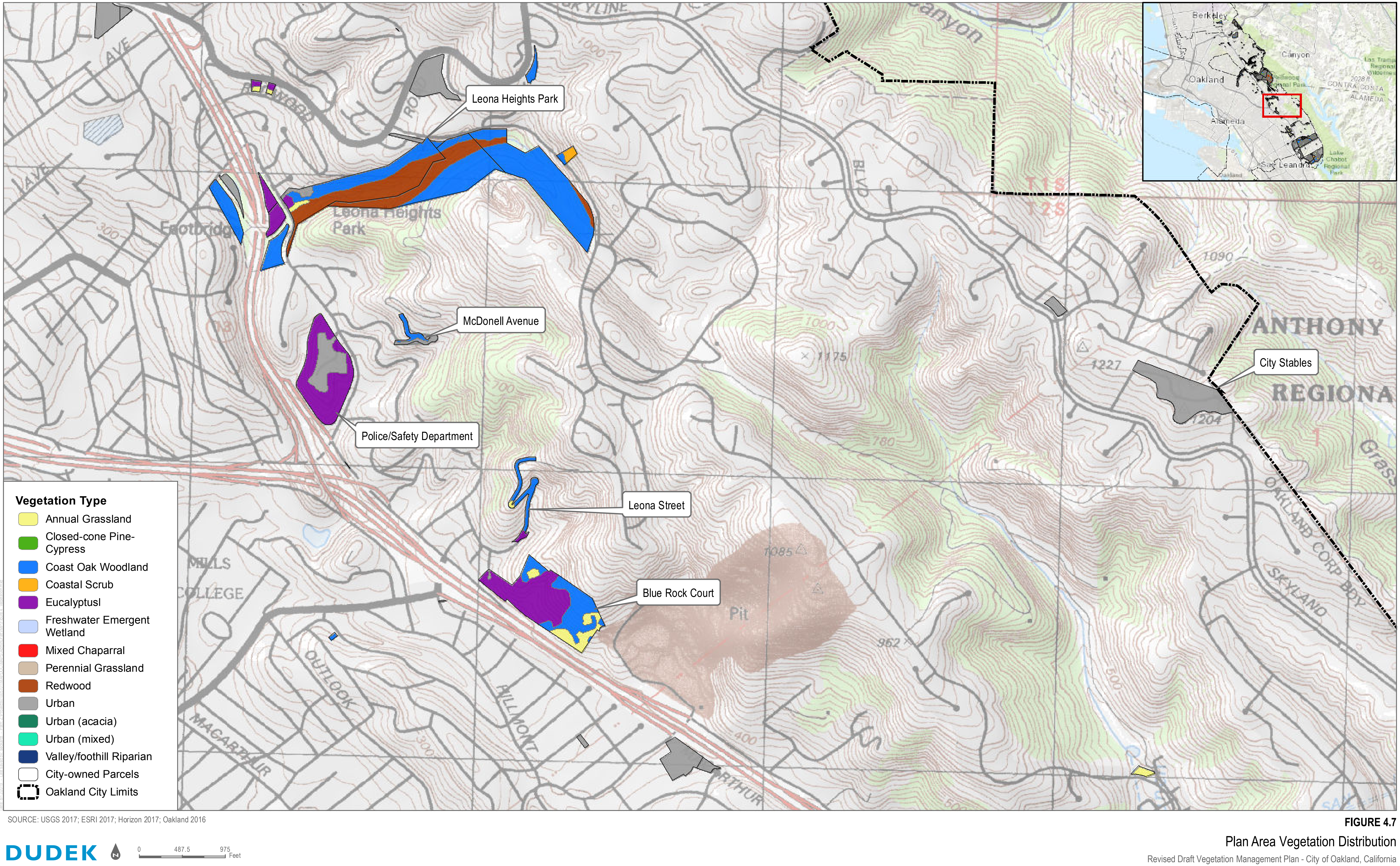

SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

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FIGURE 4.7

Plan Area Vegetation Distribution

Revised Draft Vegetation Management Plan - City of Oakland, California

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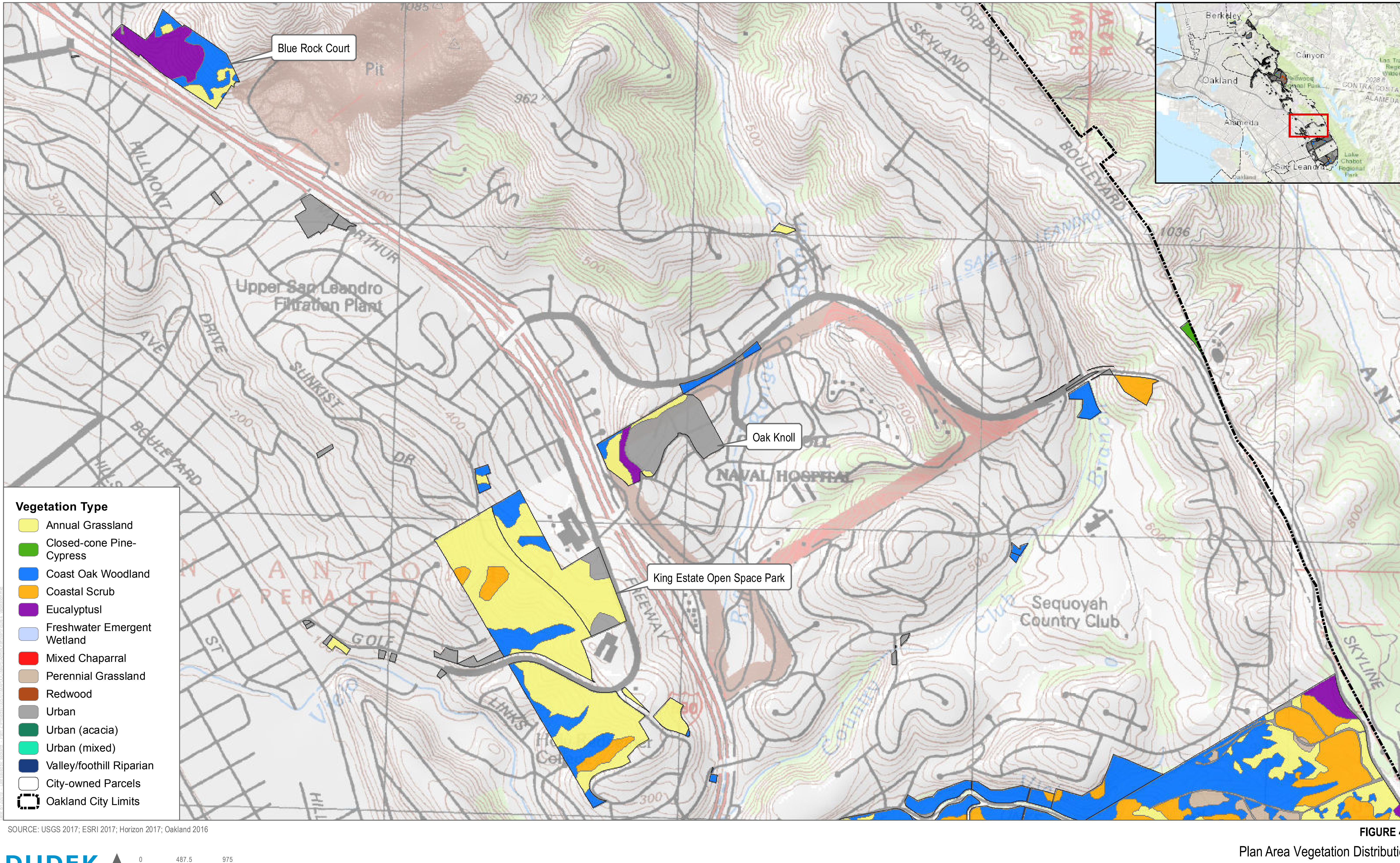

SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

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FIGURE 4.8

Plan Area Vegetation Distribution

Revised Draft Vegetation Management Plan - City of Oakland, California

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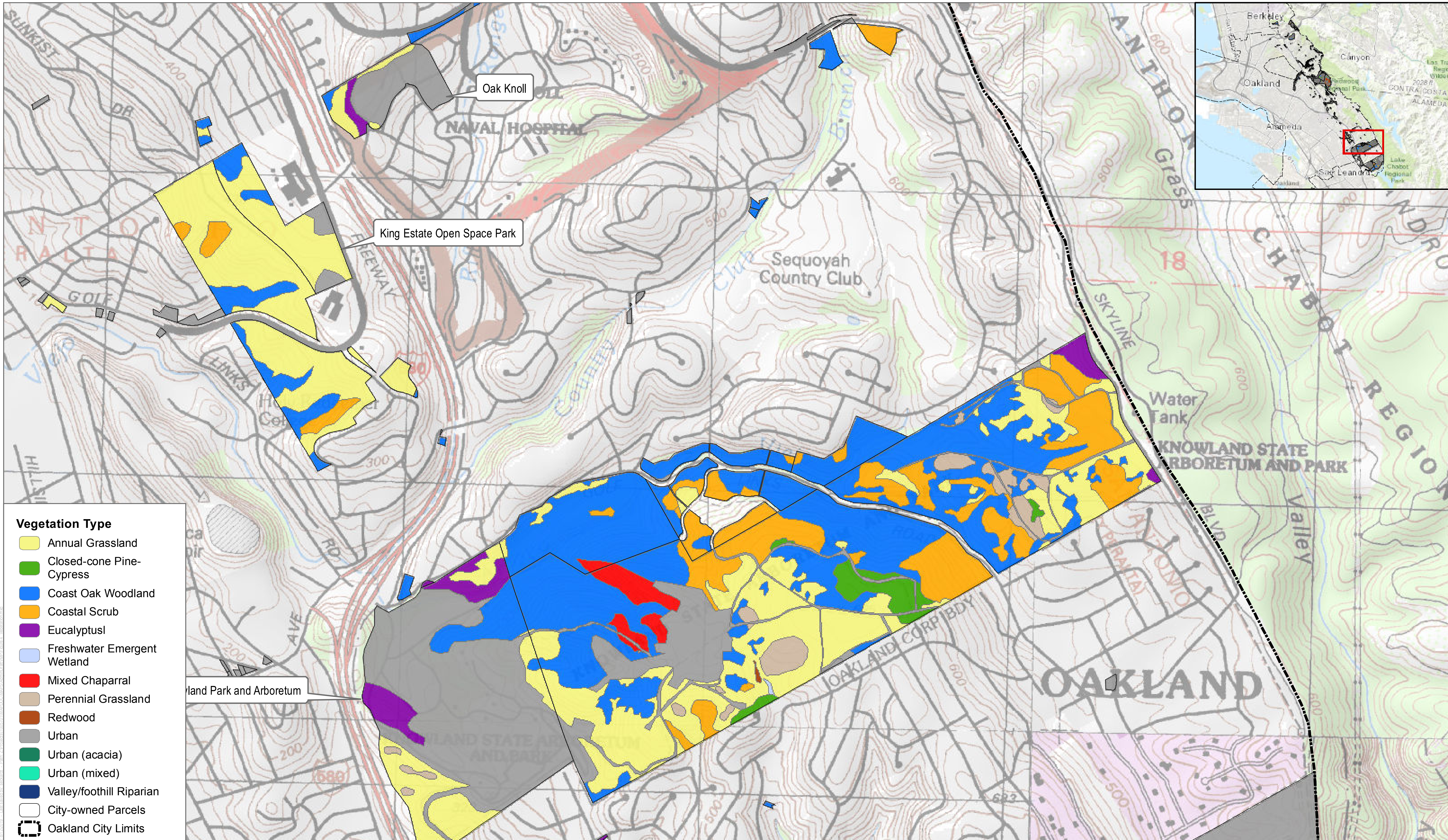

SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

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FIGURE 4.9

Plan Area Vegetation Distribution

Revised Draft Vegetation Management Plan - City of Oakland, California

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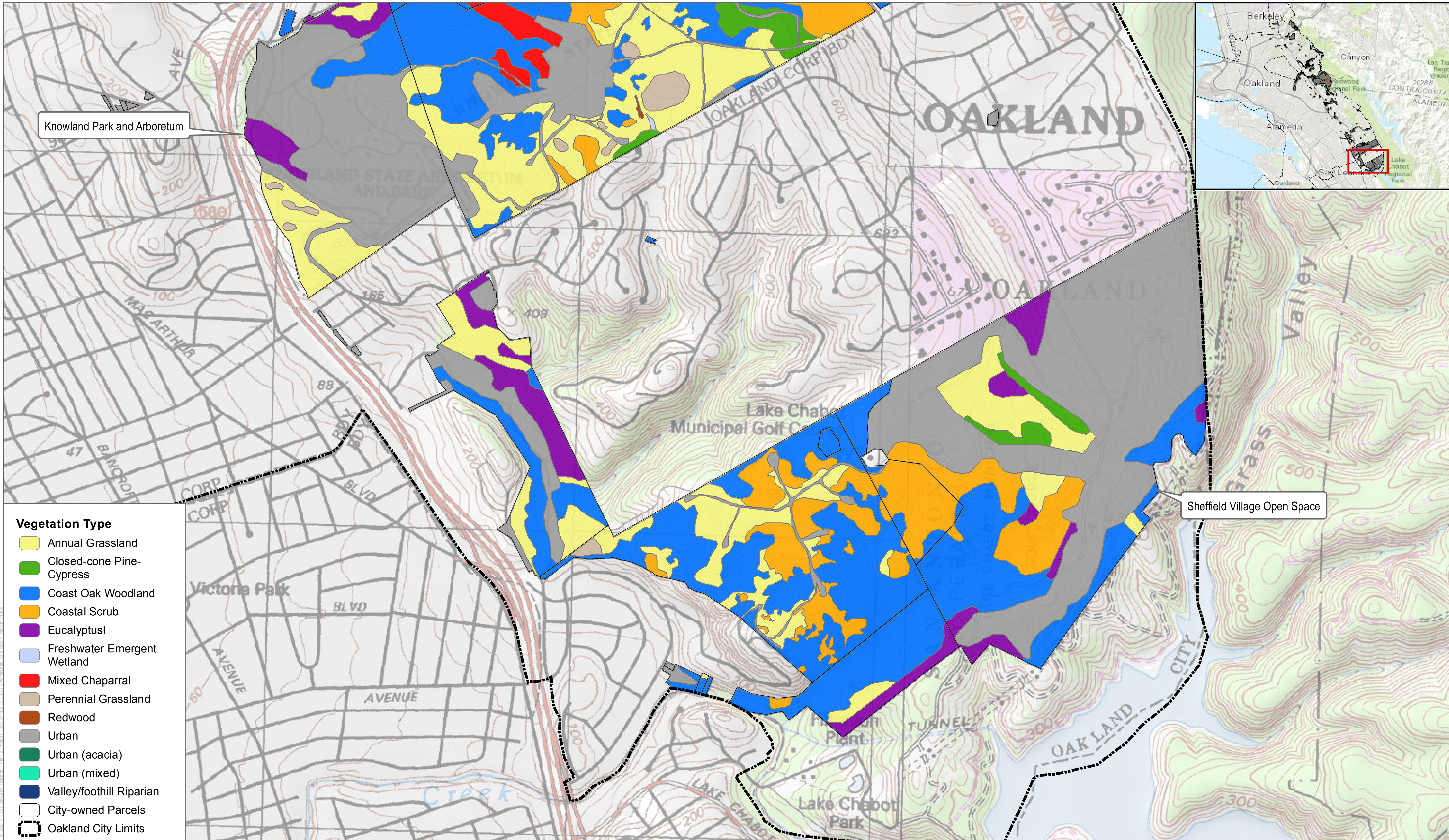

SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

DUDEK 0 487.5 975 Feet

FIGURE 4.10

Plan Area Vegetation Distribution

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2.3.1.1 Grassland/Herbaceous

Grassland/herbaceous fuels in the Plan Area are represented by the annual grassland and perennial grassland vegetation community/land cover types. Grassland types may include scattered and widely spaced trees and/or shrubs, although grasses are the dominant cover type. Grasses are fine fuels that are loosely compacted with a low fuel load.[3] Grasses have a high surface area-to-volume ratio, requiring less heat to remove fuel moisture and raise fuel to ignition temperature. They are also subject to early seasonal drying in late spring and early summer. Live fuel moisture content in grasses typically reaches its low point in early summer, and grasses begin to cure soon after. Due to these characteristics, grasses have potential for a high rate of spread, rapid ignition, and facilitation of extreme fire behavior. Grasses are the vegetation type in the Plan Area with the highest risk for wildfire ignition. Their low overall fuel loads typically result in faster moving fires with lower flame lengths and heat output. Untreated grasses can help spread fire into other adjacent surface fuel types (e.g., shrubs) or facilitate surface to crown fire[4] transition where they exist beneath tree canopies.

2.3.1.2 Brush/Scrub

Brush/scrub fuels in the Plan Area are represented by the mixed chaparral and coastal scrub vegetation community/land cover types. Brush/scrub types may include scattered and widely spaced trees, small patches of grass/herbaceous vegetation, or grass herbaceous vegetation occurring beneath shrub canopies, although shrubs are the dominant cover type.

Chaparral

Chaparral is considered a moderately fine fuel which is loosely compacted and has a moderate fuel load. Chaparral has a high surface area-to-volume ratio, requiring less heat to remove fuel moisture and raise fuel to ignition temperature. Chaparral is subject to early seasonal drying in the late spring and early summer, but does not fully cure in the way that grasses do. The live fuel moisture content reaches its low point in the late summer and early fall months. Dead fuels consist mainly of 1-hour and 10-hour fuel sizes, or twigs and small stems ranging from 0.25 inches to 1 inch in diameter. Chaparral has the potential for a high rate of spread, rapid ignition, and extreme fire behavior given its high content of volatile organic compounds (VOCs).

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[3] The amount of available and potentially combustible material, usually expressed as tons/acre (SKCNP 2017).
[4] A crown fire is a forest fire that advances often at great speed from tree top to tree top.

Coastal Scrub

Coastal scrub is considered a moderately fine fuel that is loosely compacted with a moderate fuel load. Coastal scrub has a high surface area-to-volume ratio, requiring less heat to remove fuel moisture and raise fuel to ignition temperature. It is subject to early seasonal drying in the late spring and early summer, but does not fully cure in the way that grasses do. Compared to chaparral, coastal scrub tends to have a lower content of VOCs. The live fuel moisture content reaches its low point in the late summer and early fall months. Dead fuels consist mainly of 1-hour and 10-hour fuel sizes, or twigs and small stems ranging from 0.25 inches to 1 inch in diameter. Coastal scrub has potential for a high rate of spread, rapid ignition, and extreme fire behavior.

2.3.1.3 Tree/Woodland/Forest

Tree/woodland/forest fuels in are the Plan Area represented by the coast oak woodland, eucalyptus, closed-cone pine-cypress, redwood, and valley/foothill riparian vegetation community/land cover types. Additionally, for the purposes of this VMP, the two tree-dominated urban land cover type designations (urban (acacia) and urban (mixed tree stand)) are considered within this general vegetation type. Tree/woodland/forest types may also include scattered shrubs or shrub groupings, small patches of grass/herbaceous vegetation, or shrub and grass herbaceous vegetation occurring beneath tree canopies, although trees are the dominant cover type.

Oak Woodland

Oak stands are composed of fuel structures ranging from fine to heavy. In closed canopy stands, a sparse understory of grass, leaves, twigs, branches, and bark litter may be present. In open stands, understory may include grass, shrubs, leaves, twigs, branches, and bark litter. Fuel buildup occurs very slowly in oak woodland stands in California (USFS 2015), and litter forms a thick, compacted mat resulting in very low surface fuel loads. Oak woodland understory fuel loads are low.

Oak trees are highly flame resistant as the leaves do not readily catch fire. Fires in oak stands tend to smolder in the duff, and consume surface fuels without generating enough heat to carry fire into the oak canopy (USFS 2015). Oaks also do not spread fire crown-to-crown readily like many conifers (Sonoma Veg Map 2018). Oak woodland litter does little to facilitate fire spread as it has a low surface area-to-volume ratio and requires high heat levels to remove fuel moisture and raise fuel to ignition temperature. Oak woodland litter is subject to seasonal drying in the late summer and early fall months, but fog drip, solar shading, and the windbreak provided by oak canopies can sustain high fuel moisture content in the summer when fog is present. Oaks have a low content of VOCs, and the lack of highly-combustible oils further reduces the fire hazard associated with oaks and oak woodlands.

Dead fuels consist of 1-hour (litter and duff < 0.25 inches in diameter), 10-hour (twigs and small stems 0.25 inches to 1 inch in diameter), 100-hour (branches 1 inch to 3 inches in diameter), and 1,000-hour (large stems and branches > 3 inches in diameter) sizes. Oak woodlands are mostly lacking in features that promote fire spread, but weather and topography have a strong influence on fire behavior. Given extreme fire weather and steep terrain, oak woodlands have the potential for a moderate rate of spread, torching and crown fire, and extreme fire behavior. Fire behavior in oak woodlands and forests is typically much less intense than wildfires burning in chaparral and coastal scrub communities. Low, compacted leaf litter understory, canopy shading of ground fuels, and wind velocity reduction from tree canopies significantly reduces the intensity and spread rates of surface fires in oak woodlands. Transition from ground to canopy fire increases fire intensity, spotting, and tree mortality potential.

Eucalyptus

Eucalyptus stands and individual trees in the Plan Area are predominantly blue gum (*Eucalyptus globulus*). Eucalyptus stands are composed of fuel structures ranging from fine to heavy, and may include an understory of grass, brush, eucalyptus seedlings, saplings, and small trees, and eucalyptus leaf, twig, branch and bark litter. Eucalyptus litter is generally moderately compacted with heavy to very heavy fuel loads; fuel loads in eucalyptus stands can reach between 45 and 100 tons per acre (Agee et al. 1973). Fuel buildup in blue gum eucalyptus stands is very rapid, exceeding that of other tree species, and its litter (dead leaves and debris) is especially flammable (Agee et al. 1973; NPS 2006; Wolf and DiTomaso 2016). Fuel reduction programs in eucalyptus stands are typically recommended to maintain low fuel load levels (USFS 2013).

The leaves of blue gum eucalyptus may be moderately resistant to combustion under some circumstances (Dickinson and Kirkpatrick 1985); however, these trees are considered highly flammable as the bark catches fire readily and deciduous bark streamers and lichen epiphytes tend to carry fire into the canopy, which tends to produce embers that can be carried by strong winds. These flying embers are carried downwind and result in the development of spot fires that have ignited in receptive fuel beds in advance of the fire’s leading edge (Ashton 1981; USFS 2015). Peeling bark is typical of many other eucalyptus species and contributes to ground-based fuels (litter) when it falls. Peeling bark is also retained for a period of time on tree trunks, where it can facilitate ground to canopy fire transition (ladder fuel). Eucalyptus litter has a moderate surface area to volume ratio, requiring moderate heat to remove fuel moisture and raise fuel to ignition temperature. Eucalyptus litter is subject to seasonal drying in the late summer and fall, but fog drip, solar shading, and windbreaks provided by the eucalyptus canopy can sustain high fuel moisture content in the summer when fog is present.

A recent analysis of the 2017 wildfires in Sonoma County (Sonoma Veg Map 2018) emphasized eucalyptus fire hazard potential. In this analysis, crown fire was observed to have fully consumed eucalyptus stand canopies, with less damage occurring in adjacent non-eucalyptus forest types. Data resulting from this study also revealed that of eucalyptus stands that burned in the three fires (Nuns, Tubbs, and Pocket Fires), 64% had canopy damage in the 80-100% range, indicating near or full tree crown consumption by fire. Canopy damage in the 80-100% range was lower for other forest types (22% for oak, 47% for redwood, 8% for riparian, and 37% for California bay [*Umbellularia californica*]), with the exception of Monterey pine (*Pinus radiata*) stands, 100% of which had canopy damage in the 80-100% range. This document recommends stand thinning and understory (ladder) fuel treatment to reduce fire hazard in retained eucalyptus stands.

Like chaparral, eucalyptus also has a higher content of VOCs. Eucalyptus leaves produce a volatile (Gabbert 2014), highly combustible oil, and flammable gasses may be released from trees at very high temperatures, further increasing fire hazard (Gross 2013). The live fuel moisture content reaches its low point in the late summer and early fall months. Dead fuels consist of 1-hour (litter and duff < 0.25 inches in diameter), 10-hour (twigs and small stems 0.25 inches to 1 inch in diameter), 100-hour (branches 1 inch to 3 inches in diameter), and 1,000-hour (large stems and branches > 3 inches in diameter) sizes. Features that promote fire spread include heavy litter fall, flammable oils in the foliage, and open crowns bearing pendulous (i.e., downward-hanging) branches, which encourage maximum updraft (USFS 2015). Given average weather conditions and terrain, eucalyptus has potential for a high rate of spread, torching and crown fire, and extreme fire behavior.

Closed-Cone Pine-Cypress

Closed-cone pine-cypress stands in the Oakland Hills is primarily comprised of Monterey pine and Monterey cypress (*Hesperocyparis macrocarpa*). Large portions of the closed-cone pine-cypress stands the Project Area were established via plantings in the early 1900s (Nowak 1993). Closed-cone pine-cypress stands vary in surface fuel structures ranging from fine to heavy and may include an understory of grass, brush, pine needles, twigs, branches, and bark litter. Bark and leaf litter can accumulate rapidly beneath Monterey pine trees, resulting in significant fuel loads. Monterey pine litter is a fuel that is generally moderately compacted with a heavy fuel load reaching up to 100 tons per acre. Fuel buildup occurs very rapidly in unmanaged Monterey pine stands in California (USFS 2015). Monterey pine is highly flammable; the pine needles catch fire readily and tend to carry fire into the canopy and to disseminate fire via flying embers ahead of the main fire front (USFS 2015). All Monterey pine stands burned in the 2017 wildfires in Sonoma County (Sonoma Veg Map 2018) had canopy damage in the 80-100% range, indicating near or full tree crown consumption by fire.

Monterey pine litter has a moderate surface area-to-volume ratio, requiring moderate heat to remove fuel moisture and raise fuel to ignition temperature. Monterey pine litter is subject to seasonal drying in the late summer and early fall months. The understory is more exposed than that of eucalyptus, although the fog drip, solar shading, and windbreak provided by the canopy can sustain high fuel moisture content in the summer when fog is present.

Like chaparral and eucalyptus, Monterey pine also has a higher content of VOCs and needles that produce a volatile (Gabbert 2014), highly combustible oil, and flammable gasses may be released from trees at very high temperatures, further increasing fire hazard (Gross 2013). The live fuel moisture content reaches its low point later in the late summer and early fall months. Dead fuels consist of 1-hour (litter and duff < 0.25 inches in diameter), 10-hour (twigs and small stems 0.25 inches to 1 inch in diameter), 100-hour (branches 1 to 3 inches in diameter), and 1,000-hour (large stems and branches > 3 inches in diameter) sizes. Features that promote fire spread include heavy litter fall, flammable oils in the foliage, and retention of dead needles that promote ignition within the canopy (USFS 2015). Given average weather conditions and terrain, Monterey pine has potential for a high rate of spread, torching and crown fire, and extreme fire behavior.

Redwood

Redwood stands are composed of fuel structures ranging from fine to heavy including a sparse understory vegetation typically consisting of ferns, grasses, leaves, twigs, branches, and bark litter. Bark and leaf litter tend to accumulate slowly beneath redwood trees, resulting in low fuel loads. Redwood litter is generally heavily compacted with a moderate fuel load reaching up to 100 tons per acre. Fuel buildup occurs very slowly in redwood stands in California (USFS 2015). Redwood is highly flame resistant, and the leaves do not catch fire readily. Fires tend to smolder in the duff, and consume surface fuels without generating enough heat to carry fire into the canopy (USFS 2015).

Redwood litter does little to facilitate the spread of fire. It has a low surface area-to-volume ratio and requires high heat to remove fuel moisture and raise fuel to ignition temperature. Redwood litter is subject to seasonal drying in the late summer and early fall months, but fog drip, solar shading, and windbreak provided by the redwood canopy can sustain high fuel moisture content throughout the year. Redwood has a low content of VOCs and lacks highly combustible oils, which further reduces the fire hazard associated with redwood.

Dead fuels consist of 1-hour (litter and duff < 0.25 inches in diameter), 10-hour (twigs and small stems 0.25 inches to 1 inch in diameter), 100-hour (branches 1 inch to 3 inches in diameter), and 1,000-hour (large stems and branches > 3 inches in diameter) sizes. Redwood stands are mostly lacking in features that promote fire spread, but weather and topography have a strong influence on fire behavior. Given extreme fire weather and steep terrain, redwood has potential for a moderate rate of spread, torching and crown fire, and extreme fire behavior.

Valley/Foothill Riparian

Valley/foothill riparian vegetation communities are concentrated within the drainages in the Plan Area and are characterized by willows (*Salix* spp.), white alder (*Alnus rhombifolia*), bigleaf maple (*Acer macrophyllum*), and red alder (*Alnus rubra*) (Appendix B). Riparian woodlands have a low fire hazard as their high moisture levels limit ignition potential and minimize the potential for wildfire spread. The vegetation within riparian woodlands responds slowly to changes in temperature and moisture, and significant surface shading from tree canopies limits fuel moisture loss. Surface fuels are relatively low in riparian woodlands; however, storm-related high water streamflow can deposit debris and contribute to fuel buildup as it dries out later in the season. During severe weather conditions, high fuel loads can result in high-intensity burning.

Urban

The urban vegetation community/land cover type typically represents noncombustible types (e.g., pavement) or developed and maintained landscapes (e.g., buildings, turf in parks), although some areas may be disturbed lands characterized by annual or perennial grass cover. Two of the vegetation communities/land cover types mapped as urban that include vegetation are urban (acacia) and urban (mixed tree stand). Both vegetation communities are primarily located in Joaquin Miller Park and Dimond Canyon. The areas mapped as urban (acacia) are acacia-dominated stands with little representation of other tree species. The one tree stand mapped as urban (mixed tree stand) is comprised of acacia, oak, pine, and redwood trees. Acacia stands and individual trees within the Plan Area consist of blackwood acacia (*Acacia melanoxylon*), silver wattle (*Acacia dealbata*), and black wattle (*Acacia mearnsii*). These trees or tree-form shrubs are moderately fast growing, species that tend to shade out other trees, including alders and oaks. Blackwood acacia can grow as individual trees up to 40 feet tall. The other acacia species can grow as evergreen large shrubs in dense thickets. Acacias can be fire-stimulated with prolific regeneration from long-lived seed and sprouts after fire. In addition to the oils in the leaves or phyllods (i.e., expanded leaf stocks) and dried, curly seed pods, acacias are brittle and can break in high winds, increasing the buildup of downed debris and ladder fuels in the understory. Given their physical characteristics, acacia trees (in stands or intermixed with other tree species) contribute to increased fire hazard.

2.3.1.4 Other High Fire Risk Plants

High fire risk plant species which have the potentially to spread rapidly in the Plan Area may occur within any of the identified vegetation community/land cover types. These plants can increase the frequency of fires by providing more continuous fuels that are more easily ignited (Brooks et al. 2004). Broom and pampas/jubata grass are of primary concern in the Plan Area, although others have been identified (as listed below). Some of the plants listed below are listed by the California Invasive Plant Council (Cal-IPC; Cal-IPC 2017).

Broom

One of the primary high fire risk/rapidly spreading plant types of concern in the Plan Area is broom: French broom (*Genista monspessulana*), Scotch broom (*Cytisus scoparius*), and Spanish broom (*Spartium junceum*). All are identified as Cal-IPC invasive species. Dense broom infestations produce large amounts of dry matter, which can create a serious fire hazard (DiTomaso 1998). Broom spreads by prodigious seed production and may also sprout from the root crown (Bossard 2000) or upper stem (Boyd 1995) when aboveground parts are removed by grazing, cutting, freezing, or fire. A review by Bossard (2000) suggests that broom burns readily and carries fire to the tree canopy layer, increasing both the frequency and intensity of fires in invaded areas. Similarly, Parsons and Cuthbertson (1992) suggest that broom causes concern in forest areas in Australia because it forms a flammable understory at the forest edge, where fires are most likely to start. Conversely, combustion of live, standing broom is difficult under conditions in which prescribed burns are typically conducted in California (cool, wet, low-wind days that provide lower risk of an escaped fire), unless fuel loads are artificially increased. Despite high temperatures and low humidity, researchers in Marin County, California, were unable to burn a mature, uncut broom stand, and a young uncut stand had only spotty combustion (Odion and Haubensak 2002).

Pampas Grass/Jubata Grass

Pampas grass (*Cortaderia selloana*) and jubata grass (*C. jubata*) were also observed in the Plan Area. Pampas grass is a large, clumping grass, about 6 feet to 8 feet (1.8 meters to 2.4 meters) tall. Jubata grass looks very similar, but is typically smaller in height, about 3-5 feet. These grasses are aggressive spreading, ornamental species that produce significant amounts of biomass, which is extremely flammable, thus increasing the potential for fire ignition and/or spread. These species produces an abundance of seed, which is light and can be windblown into the surrounding areas (Cal-IPC 2017). The Cal-IPC inventory categorizes pampas grass and jubata grass as having an overall rating of “high,” and these species are ranked as a high priority for removal/control within the Plan Area because of their ability to spread rapidly and contribute to the spread of wildfire.

Additional Plants

The following high fire risk/rapidly spreading plants occur in the Plan Area and contribute to increased fire hazard:

- Acacia species – silver wattle, blackwood acacia, and others (*Cal-IPC Limited, Moderate, and Watch*[5] *invasive species*)
- Blackberry (*Rubus armeniacus, Cal-IPC High invasive species*] and *R. ulmifolius*)
- Cotoneaster (*Cotoneaster franchetii, C. lacteus,* and *C. pannosus*) (*Cal-IPC Moderate invasive species*)
- Elm (*Ulmus* spp.)
- Eucalyptus species – blue gum and red gum (*E. camaldulensis*) (*Cal-IPC Limited invasive species*)
- Gorse (*Ulex europaea*) (*High Cal-IPC invasive species*)
- Hawthorn (*Crataegus monogyna*) (*Limited Cal-IPC invasive species*)
- Holly (*Ilex aquifolium*) (*Limited Cal-IPC invasive species*)
- Jubata grass (*Cortaderia jubata*) (*High Cal-IPC invasive species*)
- Mayten (*Maytenus boaria*)
- Plum and cherry (*Prunus* spp.) (*Prunus cerasifera* is a *Limited Cal-IPC invasive species*)

2.3.2 Vegetative Fire Hazard

The following sections summarize vegetative fire hazard according to the different vegetation types observed in the Plan Area. As stated, hazardous fuels include live and dead vegetation that exists in a condition that readily ignites; transmits fire to adjacent structures or ground, surface, or overstory vegetation; and/or is capable of supporting extreme fire behavior. All vegetation will burn; however, some plants exhibit characteristics that make them more flammable than others.[6] Flammability can be defined as a combination of ignitability, combustibility, and sustainability, where ignitability is the ease of or the delay of ignition, combustibility is the rapidity with which a fire burns, and sustainability is a measure of how well a fire will continue to burn with or without

5 High, Moderate, or Limited values reflect the level of each species' negative ecological impact. It is important to note that even Limited species are invasive and should be of concern to land managers. Values represent cumulative impacts statewide, therefore, a plant whose statewide impacts are categorized as Limited may have more severe impacts in a particular region. Species classified as 'Watch' pose a high risk of becoming invasive in the future in California (Cal-IPC 2017).

6 Highly flammable plants are also referred to as pyrophytes or pyrophytic.

an external heat source (White and Zipperer 2010). Flammability is influenced by several factors, which can be classified into two groups: physical structure (e.g., branch size, leaf size, leaf shape, surface-to-volume ratio, and/or retention of dead material) and physiological elements (e.g., volatile oils, resins, and/or moisture content) (Moritz and Svihra 1998; UCCE 2016; UCFPL 1997; White and Zipperer 2010). Plants that are less flammable have low surface-to-volume ratios, high moisture contents, and minimal dead material or debris, while those that are more flammable have high surface-to-volume ratios, exhibit low moisture contents, contain volatile oils, and have high levels of dead material or debris (Moritz and Svihra 1998; UCFPL 1997; UCCE 2016; White and Zipperer 2010). Plant condition and maintenance is also an important factor in flammability. Some plants that have more flammable characteristics can become less flammable if well maintained and irrigated, but can also be explosively flammable when poorly maintained, or situated on south-facing slopes, in windy areas, or in poor soils (Moritz and Svihra 1998). In general, most vegetation within the Plan Area is not regularly irrigated or maintained for the purposes of promoting overall plant health.

Research into plant flammability has resulted in the development of plant lists in many California jurisdictions intended to promote the planting and retention of less flammable plants in defensible space zones, the WUI, or areas where vegetation management aims to reduce fire hazard (UCCE 2016; UCFPL 1997; Nader et al. 2007, Moritz and Svihra 1998). Plant lists typically identify recommended low flammability (or firewise) plants and highly flammable plants that are not recommended for retention or planting. A list of high fire hazard (pyrophytic) plant species is included in Appendix D and is derived from plant lists developed by the City of Oakland (2017a) and Moritz and Svihra (1998) and those identified as highly flammable/rapidly spreading plants in Section 2.3.1.4 (Cal-IPC 2017).

Forest pests, such as insects, fungi, other microbes, and vertebrates, are a natural component of California forests. Populations of pests are dynamic and fluctuate in response to climatic and environmental changes such as drought, stand density, fire, and other site disturbances. Healthy, vigorous trees are typically able to withstand pest attacks, when pest populations are at endemic levels. When stressors exist in forests (e.g., overstocking, shading, drought), tree vigor is reduced and tree susceptibility to pest attacks and infestations increases. The Plan Area is located within the Pitch Canker Zone of Infestation (CAL FIRE 1998) and the sudden oak death (SOD) Zone of Infestation (CAL FIRE 2005) and the “Regulated Area” for SOD as designated by the California Department of Food and Agriculture (CDFA). Eucalyptus longhorn borer beetles have also been documented in the Plan Area. These diseases/pests can contribute to wildfire hazard by increasing dead surface fuel loads and hindering firefighting efforts. See Section 10.6 for more information on these pathogens.

2.3.3 Wildfire Types and Potential Fire Behavior

Several wildfire types exist, as summarized below:

- **Ground Fire:** A fire burning on the ground or through understory vegetation and not reaching into the canopy (SKCNP 2017).
- **Surface Fire:** A fire burning along the surface without significant movement into understory or overstory vegetation, with low flame lengths, usually less than 1 meter (SKCNP 2017).
- **Crown Fire:** A fire that has burned upward from the ground and into the tree canopy. There are three types of crown fires:
  - **Passive Crown Fire:** A crown fire in which individual or small groups of trees torch out, but solid flaming in the canopy cannot be maintained except for short periods. Passive crown fire encompasses a wide range of crown fire behavior from the occasional torching of an isolated tree to a nearly active crown fire. Also called torching (Scott and Reinhardt 2001).
  - **Active Crown Fire:** A crown fire in which the entire fuel complex becomes involved, but the crowning phase remains dependent on heat released from the surface fuels for continued spread. Also called running and continuous crown fire (Scott and Reinhardt 2001).
  - **Independent Crown Fire:** A crown fire that spreads without the aid of a supporting surface fire (Scott and Reinhardt 2001).

Another component of fire behavior is spotting, the transfer of fire brands (embers) ahead of a fire front which can ignite smaller vegetation fires (SKCNP 2017). These smaller fires can burn independently or merge with the main fire. Spotting can also result in structural ignitions when transported embers reach a receptive fuel bed (e.g., combustible roofing), especially in wind-driven fires, such as those occurring during Diablo wind events in the Oakland Hills. Structure fires as well as vegetation-fueled fires can generate fire brands. Additionally, landscape features like ridges can dramatically affect fire behavior by changing prevailing wind patterns, funneling air, and increasing wind speeds, thereby intensifying fire behavior.

Each of the aforementioned fire types may occur within the Plan Area, depending on site-specific conditions. Fire behavior is the manner in which a wildland fire reacts to weather, fuels, and topography. The difficulty of controlling and suppressing a wildfire is typically determined by fire behavior characteristics, such as rate-of-spread, fireline intensity, torching, crowning, spotting, fire persistence, and by resistance to control (SKCNP 2017). Extreme fire behavior is that which precludes methods of direct control (e.g., flame lengths 8 feet and greater), behaves unpredictably and erratically, and typically involves high spread rates, crowning and/or spotting, the presence of fire whirls, and a strong convective column (NWCG 2017).

Fire behavior characteristics are an important component in understanding fire risk and fire agency response capabilities. Flame length—the length of the flame of a spreading surface fire within the flaming front—is measured from midway in the active flaming combustion zone to the average tip of the flames (Andrews et al. 2008). While it is a somewhat subjective and nonscientific measure of fire behavior, it is extremely important to fireline personnel when evaluating fireline intensity, and is worth considering as an important fire variable (Rothermel 1993). Fireline intensity is a measure of heat output from the flaming front and also affects the potential for a surface fire to transition to a crown fire. The information in Table 4 presents an interpretation of flame length and its relationship to fire suppression efforts. Further discussion of flame lengths as they relate to different vegetation types in the Plan Area is provided in Section 3.3.

Table 4
Fire Suppression Interpretation

Flame Length	Fireline Intensity	Interpretations
Under 4 feet	Under 100 BTU/ft/s	Fires can generally be attacked at the head or flanks by persons using hand tools. Hand line should hold the fire.
4 feet to 8 feet	100–500 BTU/ft/s	Fires are too intense for direct attack on the head by persons using hand tools. Hand line cannot be relied on to hold the fire. Equipment such as dozers, pumpers, and retardant aircraft can be effective.
8 feet to 11 feet	500–1,000 BTU/ft/s	Fires may present serious control problems—torching out, crowning, and spotting. Control efforts at the fire head will probably be ineffective.
Over 11 feet	Over 1,000 BTU/ft/s	Crowning, spotting, and major fire runs are probable. Control efforts at head of fire are ineffective.

Note: BTU/ft/s = British thermal units per foot per second.
Source: Roussopoulos and Johnson 1975.

2.4 Fire History and Ignitions

Fire history is an important component in understanding fire frequency, fire type, significant ignition sources, and vulnerable areas. The topography, vegetation, and climatic conditions associated with the Plan Area combine to create a unique situation capable of supporting large-scale, high-intensity, and sometimes damaging wildfires, such as the 1991 Tunnel Fire. The history of wildfires in the Plan Area is presented in Table 5.

Table 5
History of Wildfires in the Oakland Hills

Year	Month	Wind	Acres	Structures Lost	Location
1923	September	Diablo	130	584	North of UC Berkeley Campus
1931	November	Diablo	1,800	5	Leona Canyon
1933	November	Diablo	1,000	5	Joaquin Miller
1937	September	Westerly	700	4	Broadway Terrace
1940	September	Westerly	30	0	Broadway Terrace
1946	September	Diablo	1,000	0	Buckingham/Norfolk
1955	November	Westerly	10	0	Montclair
1960	October	Diablo	1,200	2	Leona Canyon
1961	November	South-Westerly	400	0	Briones Regional Park, Tilden Regional Park, Roberts Regional Recreation Area, Chabot Regional Park
1968	October	Westerly	204	0	North of Naval Hospital
1970	September	Diablo	204	37	Buckingham/Norfolk
1980	December	Diablo	2	5	Wildcat Canyon Road, Berkeley
1990	October	Westerly	200	0	Leona Canyon
1991	October	Diablo	1,700	3,000	Buckingham/Norfolk
2017	July	West/North	9	0	Grizzly Peak and South Park
2017	September	North	22	0	Leona Quarry
2017	October	Diablo	7	0	Elysian Fields and Gold Links Road
2017	December	Diablo	2.5	2	Snake Road and Colton Boulevard

Source: City of Oakland 2017b.

As presented in Table 5, nearly all significant wildfires have burned in the months of September, October, or November. This timeframe coincides with the end of the dry summer season, where vegetation has lower fuel moistures and Diablo winds return to the Plan Area. While not all the fires shown in Table 5 were associated with Diablo (easterly or northeasterly) winds, the largest and most damaging fires have occurred during such winds.

The history of wildfire ignitions in the Plan Area is directly related to human activity. Notable ignition locations include view spots along Grizzly Peak Boulevard or Skyline Boulevard that offer views of the San Francisco Bay and congregation areas within Joaquin Miller Park, along Skyline Boulevard near Sequoia Point. Stolen vehicle dump sites are another potential wildfire ignition source, with notable locations in Joaquin Miller Park (near Sequoia Point) and at the water tank on Skyline Boulevard, approximately 0.5 miles west of its intersection with Grass Valley Road, near the entrance to Knowland Park. Mechanized and power equipment use (e.g., mowers) on private, residential parcels is another potential ignition source, one that was responsible for igniting the 1970 Diablo Fire. Fireworks present another potential ignition source in early summer on or near July 4, notably at King Estate Open Space Park (Crudele, pers. comm. 2017). Joaquin Miller

Park has also been the location of small fires ignited by fireworks, including a 3-acre fire on July 4, 2015 and a 1.5-acre fire on July 4, 2015, which destroyed a park cabin. Other potential ignition sources within the Plan Area include power lines, camp fires, barbeques, and vehicle-originated fires along Plan Area roads, including State Routes 13 and 24 and Interstate 580.

2.5 Fire Hazard Severity Zoning

As noted, the Plan Area is located within the City's adopted VHFHSZ. Fire Hazard Severity Zones (FHSZs) are "geographical areas designated pursuant to California Public Resources Codes, Sections 4201 through 4204 and classified as Very High, High, or Moderate in State Responsibility Areas or as Local Agency Very High Fire Hazard Severity Zones designated pursuant to California Government Code, Sections 51175 through 51189" (California Building Standards Commission 2016). Oakland's VHFHSZ is a Local Agency VHFHSZ, as defined, and the City is considered a Local Responsibility Area (LRA). OFD is the responsible agency for fire protection within the City's VHFHSZ. The Plan Area abuts lands where the responsibility for fire protection lies with the State of California (State Responsibility Areas (SRA)). The boundary of SRA lands proximate to the Plan Area is depicted in Figure 2.

California Public Resources Code Sections 4201–4204 and Government Code Sections 51175–51189 direct California Department of Forestry and Fire Protection (CAL FIRE) to map areas of significant fire hazards based on fuels, terrain, weather, and other relevant factors. The resulting FHSZs define the application of various mitigation strategies to reduce risk associated with wildland fires (CAL FIRE 2016a). The model used to determine the extent of FHSZs is based on an analysis of potential fire behavior, fire probability predicated on frequency of fire weather, ignition patterns, expected rate of spread, ember (brand) production, and/or past fire history (CAL FIRE 2016a). Structures built in FHSZs are subject to more stringent fire hardening requirements than those that are not.

2.6 Wildland Urban Interface/Intermix

The pattern of development and land use within the City's VHFHSZ creates conditions that can be described as either a wildland urban interface or a wildland urban intermix. Urban areas are predominantly built-up environments with little or no exposure to vegetative fuels. Such areas are located primarily to the west of the City's VHFHSZ. The area where urban development abuts vegetative fuels is known as the wildland urban interface (WUI). This condition exists within the City's VHFHSZ where structures abut City parklands and open space. Areas where the density of housing units and structures is lower and/or the space between structures consists of vegetative fuels capable of propagating fire are more typically characterized as a wildland urban intermix (Intermix). This condition exists throughout the City's VHFHSZ, notably where smaller undeveloped lots consisting of vegetative fuels are situated between structures. Both conditions present advantages and disadvantages with respect to reducing wildfire hazard, as described below.

2.6.1 Wildland Urban Interface

WUI areas are those within the "vicinity" of wildland vegetation. The wildland fire risk associated with WUI areas includes propagation of fire throughout WUI communities via house-to-house fire spread, landscaping-to-house fire spread, or ember intrusion. Advantages and disadvantages associated with WUI areas are as follows.

WUI Advantages

- Community water supply systems in place
- Multiple homes accessed by a single road
- Emergency equipment protects multiple assets at once
- Houses usually only exposed to flammable fuels on one side

WUI Disadvantages

- High housing density
- Congested roads during emergencies
- Limited options if the community water systems fail

2.6.2 Wildland Urban Intermix

Intermix areas are those where housing and vegetation intermingle. In the Intermix, wildland vegetation is continuous, and more than half of the land area is vegetated with combustible fuels. The wildland fire risk associated with Intermix areas includes vegetation-to-house fire spread or ember intrusion. Advantages and disadvantages associated with Intermix areas are as follow.

Intermix Advantages

- Low housing density
- Diversity in water supply systems

Intermix Disadvantages

- Increased risk to firefighters

- Emergency equipment can only protect single assets
- Delayed emergency equipment response times due to:
  - Rural roads (single lane, windy, heavy fuel loading)
  - Long driveways
- Congested roads during emergencies
- Diversity in water supply systems
- Houses surrounded by vegetation

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3 WILDFIRE HAZARD ASSESSMENT

The wildfire hazard assessment conducted in support of this VMP involved an evaluation of field conditions, processing and analyzing spatial datasets in a GIS, conducting GIS-based modeling to identify areas that may be subject to extreme fire behavior, and identifying locations within the Plan Area that may present increased ignition potential or otherwise contribute to increase fire hazard. The assessment effort is presented in the following sections and was used to prioritize fuel treatment areas.

3.1 Field Assessments

As noted in Section 2.3.1, field assessments were conducted by Dudek between December 2016 and September 2017 in order to evaluate existing fuel load conditions and to gain an understanding of general fuel hazard conditions and current maintenance practices being conducted by OFD within the Plan Area. Field assessments were also used to identify and classify vegetation community and land cover types into fuel models, as presented in Table 3, and as discussed in more detail in Section 3.3 and Appendix C. During field assessments, site conditions were documented via photographs and, in some cases, noted on digital or hard-copy field maps. Photo-documentation of field conditions and corresponding fuel model assignments are presented in Appendix C.

3.2 GIS Analysis

Development of this VMP included assessment and processing of GIS datasets (in ArcGIS [version 10.5]), for variables influencing wildfire hazard in the Plan Area, as presented below:

- **Boundary:** The City's VHFHSZ boundary file was obtained from the City and formed the boundary for all analysis and mapping efforts conducted in support of this VMP.
- **Terrain:** Digital terrain data for the City's VHFHSZ was obtained (USGS 2013a, 2013b) and processed to develop slope and aspect datasets for use in project-related fire behavior modeling (Section 3.3 and Appendix C). This data was also analyzed to identify ridgeline locations.
- **Vegetation/Land Cover:** Vegetation mapping data (Appendix B) was analyzed and used as the base for fuel model assignments (as described in Section 3.3 and Appendix C).
- **Land Ownership:** City-owned parcel data was obtained from the City and formed the mapping base for this VMP. Parcels were reviewed and classified into broad categories (e.g., canyon, urban/residential) for development of management recommendations. All additional mapping efforts performed in development of this VMP utilized the City-owned

parcel dataset as a base, and Assessor's Parcel Numbers for each parcel were retained in all subsequent GIS datasets.

- **Roads:** Road centerline data was obtained from the City and clipped to the City's VFHSZ boundary and road distances re-calculated based on clipped lengths.
- **Structures:** Structure footprint data in polygon format was obtained from the City and clipped to the VHFHZS boundary, plus a 200-foot buffer. This data was used in subsequent buffering efforts, as described below.
- **Access Gates:** Park access gate locations in point format were obtained from the City and clipped to the VHFHZS boundary. This data was used in subsequent buffering efforts, as described below.

In addition to review of the aforementioned datasets, creation of buffering datasets was necessary to inform the prioritization recommendations included in this VMP, as some are related to distances from ridgelines and existing structures in the Plan Area. To determine the area of land within certain distances of structures, a GIS analysis was performed using buffering tools within ArcGIS (version 10.5). Using the Multiple Ring Buffer tool, 100-foot and 300-foot horizontal buffers around existing structure locations were calculated and mapped. Polygon data depicting structure footprints within the City's VHFHSZ was acquired from the City of Oakland. The structure footprint polygon data was used as the source data and buffers calculated outward. The resulting buffer polygon dataset included two distinct areas: the land area within 0 to 100 feet from structures and the land area within 100 feet to 300 feet from structures. To determine the area of land within 300 feet of ridgelines, dominant ridgelines in the Plan Area were digitized in a GIS and a GIS buffering analysis was performed to determine the area of land within 300 feet of ridgeline centerlines. A GIS buffering analysis was also performed to determine the area of land within 150 feet of park access gate locations. All buffer dataset were clipped to the City-owned parcels within the Plan Area. Fire behavior modeling efforts were also conducted in a GIS environment, as described below.

3.3 Fire Behavior Modeling

Modeling of potential fire behavior was also conducted to support development of this VMP. Specifically, the FlamMap software package was used to identify portions of the Plan Area that may be subject to extreme fire behavior, considering weather, fuels, and terrain variables. FlamMap (version 5.0.3) (Finney et al. 2015) is a GIS-driven computer program that incorporates fuels, weather, and topography data in generating static fire behavior outputs, including values associated with flame length and crown fire activity, among others. It is a flexible system that can be adapted to a variety of specific wildland fire planning and management needs. The calculations that come from FlamMap are based on the BehavePlus fire modeling system algorithms but result in geographically distinct datasets based on GIS inputs. FlamMap model outputs allow wildland resource managers to evaluate anticipated fire behavior, which provides important insight about the characteristics of wildfire spread within management areas. Each of the input variables used in FlamMap remain constant at each location, meaning that the input variables are applied consistently to each grid cell and the fire behavior at one grid cell does not impact that at a neighboring grid cell. Essentially, the model presents a "snapshot" in time and does not account for temporal changes in fire behavior or the movement of fire across the landscape. As such, the results of the models contained herein are best used as valuable information sources and tools to prioritize fuel treatments based on potential risk rather than used as a forecast tool of an exact representation of how a fire would behave in the Plan Area.

The following are the basic assumptions and limitations of FlamMap:

- The model output files describe fire behavior only in the flaming front. The primary driving forces in the predictive calculations are the dead fuels less than 0.25 inches in diameter. These are the fine fuels that carry fire. Fuels greater than 1 inch in diameter have little effect in carrying fire, and fuels greater than 3 inches in diameter have no effect.
- The model bases calculations and descriptions on a wildfire spreading through surface fuels that are within 6 feet of the ground and contiguous to the ground. Surface fuels are often classified as grass, brush, litter, or slash.
- The software assumes that fuel moisture conditions are uniform. However, because wildfires almost always burn under non-uniform conditions, length of projection period and choice of fuel must be carefully considered to obtain useful predictions.
- WindNinja software (version 2.1.0), which is incorporated into FlamMap, allows for the generation and incorporation of gridded wind data in the FlamMap simulation.

FlamMap was used to model flame length and crown fire activity for a portion of the Plan Area. A detailed discussion of the FlamMap modeling process conducted for this VMP is presented in Appendix C, which includes maps depicting the graphical outputs of the modeling runs. The results of the FlamMap modeling effort are summarized in Table 6, by location.

Table 6
Fire Behavior Modeling Results

Location	Flame Length	Crown Fire
Canyon Areas		
Garber Park	Flame lengths low (< 4 feet).	Surface fire only.
Dimond Canyon Park	Flame lengths high (> 8 feet) in coastal scrub and one coastal oak woodland area along Park Boulevard with grass/shrub understory. Flame lengths low to moderate (< 8 feet) in remaining areas of the property.	Primarily surface fire throughout the property, although small pockets of active crown fire occur the coastal oak woodland area along Park Boulevard with grass/shrub understory and in a few small areas within the drainage with high slope gradients.
Shepherd Canyon Park	Flame lengths high (> 8 feet) in area along the western side of Shepherd Canyon Road where broom exists beneath eucalyptus tree canopies. Flame lengths moderate (< 8 feet) within eucalyptus stand along Escher Drive. Flame lengths low (< 4 feet) throughout the remainder of the property.	Active and passive crown fire concentrated along the western side of Shepherd Canyon Road where broom exists beneath eucalyptus tree canopies. Surface fire throughout the remainder of the property.
Leona Heights Park	Flame lengths high (> 8 feet) in coastal oak woodlands in upland areas in the eastern and northern portions of the park. Flame lengths low (< 4 feet) within redwood stands along the drainage bottom, with some isolated active crown fire in areas with steep slope gradients. Flame lengths low (< 4 feet) within the managed eucalyptus and oak stands at the park's western edge.	Active and passive crown fire in coastal oak woodlands in upland areas in the eastern and northern portions of the park. Primarily surface fire within redwood stands along the drainage bottom, with some isolated active crown fire in areas with steep slope gradients. Surface fire only in the managed eucalyptus and oak stands at the park's western edge.
Beaconsfield Canyon	Flame lengths high (> 8 feet) in coastal scrub. Flame lengths low to moderate (< 8 feet) in coastal oak woodland and pine stands.	Active and passive crown fire in eucalyptus stands. Surface fire in coastal oak woodland and pine stands.
Ridgetop Areas		
North Oakland Regional Sports Field	Flame lengths high (> 8 feet) throughout property.	Active crown fire throughout most of the property's tree-dominated vegetation (eucalyptus and coastal oak woodland). Surface fire concentrated in managed areas along dirt access road and in the area between ball field and eucalyptus stand.
Grizzly Peak Open Space	Flame lengths high (> 8 feet) throughout coastal scrub vegetation. Flame lengths low (< 4 feet) in coastal oak woodland. Variable flame lengths within pine and eucalyptus stands (low to high, dependent on canopy base heights and shading of surface fuels).	Torching of tree canopies along upper, northeastern portion of property and active crown fire along lower, southwestern portion of property.
City Stables	Flame lengths low (< 4 feet).	Surface fire only.

Table 6
Fire Behavior Modeling Results

Location	Flame Length	Crown Fire
City Parklands and Open Space		
Sheffield Village Open Space	Flame lengths high (> 8 feet) in coastal scrub, oak stands with a heavy shrub understory, and isolated areas within oak woodlands with grass understory where slope gradients are high. Flame lengths moderate (< 8 feet) in pine and eucalyptus stands adjacent to the golf course. Flame lengths low (< 4 feet) throughout the remainder of the property.	Active crown fire in coastal scrub (where overstory trees are present), oak stands with a heavy shrub understory, and isolated areas within oak woodlands with grass understory where slope gradients are high. Surface fire only throughout the remainder of the property.
Knowland Park and Arboretum	Flame lengths high (> 8 feet) in the coastal scrub and chaparral stands in the central and eastern portions of the property. Flame lengths moderate (< 8 feet) in the eucalyptus stands in the western portion of the property. Flame lengths low (< 4 feet) throughout the remainder of the property.	Active crown fire in the coastal scrub and chaparral stands in the central and eastern portions of the property (where overstory trees are present) and in the eucalyptus stands in the western portion of the property. Surface fire only throughout the remainder of the property.
Joaquin Miller Park	Flame lengths high (> 8 feet) throughout the northern and central portions of the park within non-managed oak, pine, eucalyptus, and acacia stands and within the acacia and mixed tree stands within the southern (lower) portions of the park. Flame lengths low to moderate (< 8 feet) in the lower, developed, and managed portions of the park and along the park's western edge where it abuts Castle Drive (except acacia and mixed tree stands).	Active and passive crown fire within the northern and central portions of the park within non-managed oak, pine, eucalyptus, and acacia stands. Active and passive crown fire also within the acacia and mixed tree stands within the southern (lower) portions of the park. Surface fire only within redwood stands and throughout the lower, developed and managed portions of the park (except acacia and mixed tree stands).
King Estate Open Space Park	Flame lengths low (< 4 feet) throughout the property's coastal oak woodlands and grasslands. Flame lengths moderate (< 8 feet) in the coastal scrub and eucalyptus stands on the property.	Isolated active crown fire only in coastal scrub where overstory trees are present. Surface fire only throughout the remainder of the property.
Other (Blue Rock Court)	Flame lengths high (> 8 feet) in the eucalyptus stand in the center of the property. Flame lengths low (< 4 feet) throughout the remainder of the property.	Active and passive crown fire in the eucalyptus stand in the center of the property. Surface fire only throughout the remainder of the property.
Other (Leona Street)	Flame lengths low (< 4 feet) in coastal oak woodland and annual grassland. Flame lengths high (> 8 feet) in eucalyptus stand at the property's southern end.	Surface fire only in coastal oak woodland and annual grassland. Active crown fire in eucalyptus stand at the property's southern end.
Other (McDonell Avenue)	Flame lengths low (< 4 feet).	Surface fire only.
Other (Police/Safety Department)	Flame lengths low (< 4 feet).	Surface fire only.
Other (Tunnel Road Open Space)	Flame lengths low (< 4 feet).	Surface fire only.

Table 6
Fire Behavior Modeling Results

Location	Flame Length	Crown Fire
Other (Marjorie Saunders Park)	Flame lengths high (> 8 feet) in eucalyptus stands. Flame lengths low to moderate (< 8 feet) in coastal oak woodland and pine stands.	Active and passive crown fire in coastal scrub (where overstory trees are present). Surface fire in coastal oak woodland and pine stands.
Other (Oak Knoll)	Flame lengths low (< 4 feet) throughout the property's grasslands. Flame lengths moderate (< 8 feet) in the property's eucalyptus stand.	Surface fire only throughout the remainder of the property.

The results presented in Appendix C and summarized in Table 6 depict values based on inputs to the FlamMap software and are not intended to capture changing fire behavior as it moves across a landscape. For planning purposes, the worst-case fire behavior is the most useful information for prioritizing vegetation management activities. Model results should be used as a basis for planning only, as actual fire behavior for a given location will be affected by many factors, including unique weather patterns, small-scale topographic variations, or changing vegetation patterns.

While other fire behavior modeling systems exist (BehavePlus, FARSITE), FlamMap was selected given its capabilities for mapping potential fire behavior in a GIS-based environment, a characteristic important in fire and vegetation management planning (Finney 2006). Another system utilized for modeling potential wildfire in Australia is Project VESTA, a comprehensive research project that investigated the behavior and spread of high-intensity brushfires in dry eucalyptus forests with different fuel ages and understory vegetation. Project VESTA was designed to quantify age-related changes in fuel attributes (eucalyptus stands between 2 years to 22 years old) and fire behavior in dry eucalypt forests in southern Australia. Research findings from Project VESTA (Gould et al. 2007) were used to assess fuel characteristics in different eucalyptus forest understories and to identify better fuel parameters to input into the FlamMap fire models conducted in support of this VMP.

Finally, the BehavePlus software package (version 6.0.0) was used to highlight the difference in fire behavior characteristics for each of the different fuel models utilized for analyzing fire behavior for this VMP. Table 8 includes a summary of fire behavior characteristics, by dominant vegetation and fuel model type. This analysis utilized the same wind and weather input values as used for the FlamMap runs, as presented in Appendix C, and includes a slope gradient of 10%.

Table 7
Fire Behavior Characteristics for VMP Area Fuel Models

Fuel Model	Flame Length (ft.)	Spread Rate (mph)
Grassland/Herbaceous		
GR1 (short grass)	2.6	0.3
GR4 (moderate load grass)	29.0	11.6
Brush/Scrub		
GS2 (moderate load grass/shrub)	17.4	3.4
SH1 (low load shrub)	8.5	1.1
SH5 (high load shrub)	38.2	5.6
Tree/Woodland/Forest		
TU1 (low load, timber/grass/shrub)	5.7	0.4
TU5 (very high load timber/shrub)	19.0	0.8
TL2 (low load broadleaf litter)	1.4	>0.1
TL3 (moderate load conifer litter)	1.8	>0.1
TL6 (moderate load broadleaf litter)	8.3	0.7
TL8 (long needle litter)	9.6	0.6
TL9 (very high load broadleaf litter)	13.7	0.9

As presented in Table 7, flame lengths are lower in short grass and low to moderate load timber litter fuel models and higher in moderate load grass, shrub, and timber understory fuel models. Spread rates are also lower in short grass, low load timber/grass/shrub, and low to moderate load tree litter fuel models. For brush/scrub vegetation, flame lengths and spread rates are lower in low load shrub fuel models. The results presented in Table 7 emphasize the importance of vegetation management to modify fire behavior. The vegetation management standards included in this VMP are designed to create fuel conditions that resemble models with lower flame lengths and slower spread rates: short grass (trimmed or grazed grasslands), low load brush/scrub (thinned brush), and low load timber/litter (treated ladder fuels beneath tree canopies).

3.4 Research, Documentation, and Community Input

Development of this VMP also included research to document existing vegetation management practices being conducted by OFD in the Plan Area and to identify evidence of areas subject to high ignition potential. OFD has been actively managing vegetation since 2003 to minimize wildfire hazard in the Plan Area, utilizing various techniques (e.g., grazing, hand crews). The effort to document vegetation management efforts involved a thorough review and marking up of hard copy maps of the Plan Area by OFD, as well as a review of vegetation management contract documents provided by OFD. The current vegetation management activities being conducted by OFD at each City-owned parcel in the Plan Area were then recorded into the GIS data created for development of this VMP. A summary of current and past vegetation management activities is presented in Section 8, Vegetation Management Techniques, by management type.

Multiple conversations with OFD staff (Crudele, pers. comm. 2017) and members of the public were also conducted to better understand specific locations within the Plan Area that may be subject to increased ignition potential, as such information is not typically recorded in map format. Identification of such areas is an important consideration for identifying and prioritizing fuel treatment recommendations. The effort to document such areas also involved a thorough review and marking up of hard copy maps of the Plan Area by OFD. The results of this effort are discussed in Section 2.4, Fire History and Ignition. Community members provided input on areas of high fire risk through public meetings, written comment letters, and site visits. Detailed site visits were conducted with multiple stakeholder groups at many sites throughout the Plan Area. Public engagement is described in more detail in Section 6. Community input on fire risk has been incorporated into the VMP.

Finally, an evaluation of potential cost ranges associated with implementation and maintenance of the vegetation management recommendations included in this VMP was conducted. A summary of this evaluation and results are presented in Section 12.5.

4 CODES AND STANDARDS

This section describes existing codes and standards relevant to vegetation management activity in the Plan Area or the City's VHFHSZ.

4.1 City of Oakland

4.1.1 Protected Trees

Oakland Municipal Code Chapter 12.36 (Protected Trees) was enacted to protect and preserve trees by regulating their removal, to prevent unnecessary tree loss and minimize environmental damage from improper tree removal, to encourage appropriate tree replacement plantings, to effectively enforce tree preservation regulations, and to promote the appreciation and understanding of trees. The code defines protected trees as California or coast live oak trees (*Quercus agrifolia*) measuring 4 inches in trunk diameter at breast height or larger, and any other tree (except eucalyptus (*Eucalyptus spp.*) and Monterey pine (*Pinus radiata*)) measuring 9 inches diameter at breast height or larger on any property. Protected trees also include Monterey pine trees where they occur on City property and in development-related situations where more than five Monterey pine trees per acre are proposed to be removed. Monterey pine trees are not protected in non-development-related situations, nor in development-related situations involving five or fewer trees per acre; however, public posting of such trees and written notice of proposed tree removal to the Office of Parks and Recreation is required per Section 12.36.070A and Section 12.36.080A. Except as noted above, eucalyptus and Monterey pine trees are not protected by this ordinance. To remove any protected trees, a tree removal permit is required.

4.1.2 Hazardous Trees

Oakland Municipal Code Chapter 12.40 (Hazardous Trees) defines a "hazardous tree" as any tree which poses an imminent threat to life or property, as determined by inspection using the criteria established by Section 12.40.030. The ordinance defines procedures for removal of hazardous trees for the purpose of preventing personal injury or damage to neighboring properties.

4.1.3 Stormwater Management

Oakland Municipal Code Chapter 13.16 (Creek Protection, Stormwater Management and Discharge Control) is intended to protect and enhance the water quality of watercourses, water bodies, and wetlands in a manner pursuant to and consistent with the federal Clean Water Act and National Pollutant Discharge Elimination System Permit No. CA0029831. The ordinance outlines measures to control discharges to storm sewers; reduces pollutants in storm water discharges; safeguards and preserves creeks, riparian corridors, creekside vegetation, and wildlife; prevents activities that would contribute to flooding, erosion, or sedimentation; controls erosion and sedimentation; and protects drainage facilities.

4.1.4 Fire Code

Oakland Municipal Code Chapter 15.12 (Oakland Fire Code) and its amendments establish regulations regarding the hazard of fire and explosion arising from the storage, handling, or use of structures, materials or devices; conditions hazardous to life, property or public welfare in the occupancy of structures, or premises; fire hazards in the structure or on the premises from occupancy or operation; matters related to fire suppression or alarm systems; and conditions affecting the safety of firefighters and emergency responders during emergency operations.

The Oakland Fire Code also includes Chapter 49 (Wildland-Urban Interface Areas), which defines the City's VHFHSZ and outlines requirements for defensible space, hazardous vegetation management, electrical distribution line clearances, fire apparatus access, water supply, ignition source control, and combustible materials storage, among others. Specifically, Section 4906.3 of the Oakland Fire Code states that vegetation around all applicable buildings and structures within the VHFHSZ shall be maintained in accordance with California Public Resources Code Section 4291, California Code of Regulations Title 14 – Natural Resources, Division 1.5 – Department of Forestry and Fire Protection, "General Guideline to Create Defensible Space," and California Government Code Section 51182.

4.1.5 General Plan Open Space Conservation and Recreation Element

The Open Space Conservation and Recreation Element of the City's General Plan is the official policy document addressing the management of open land, natural resources, and parks in Oakland. It includes policies regarding topics such as flood control and discharge, creek maintenance, tree removal, wildlife corridors, and transportation management, among others. The element also discusses fire prevention measures, flammable vegetation control, fire-resistant landscape guidelines, and public education on fire suppression.

4.1.6 Comprehensive Plan Scenic Highways Element

The Scenic Highways Element, part of the Oakland Comprehensive Plan adopted in 1974 (City of Oakland 1974), addresses the preservation and enhancement of distinctively attractive roadways that traverse the City of Oakland and the visual corridors that surround them. It establishes a framework within which roads and highways can be identified as part of the Oakland Scenic Route System, enumerates policies regarding those routes, and complies with State Government Code Section 65302, which requires a Scenic Highways Element be prepared as part of the General Plan.

The plan qualifies Interstate 580 as an Official California Scenic Route and safeguards Skyline Boulevard/Grizzly Peak Boulevard/Tunnel Road as a uniquely scenic drive in the City.

4.1.7 General Plan Safety Element

The Safety Element of the General Plan was adopted in 2004 and amended in 2012. The purpose of a safety element is to reduce the potential risk of death, injuries, property damage, and economic and social dislocation resulting from large-scale hazards. By law, a safety element must address the following issues: seismically induced surface rupture, ground shaking, ground failure, tsunamis, seiches, and dam failure; slope instability leading to mudslides and landslides; subsidence, liquefaction, and other seismic and geologic hazards; flooding; wild-land and urban fires; and evacuation routes, military installations, peak-load water supply requirements and minimum road widths and clearances around structures, as those items relate to identified fire and geologic hazards. The fire hazards section of the Safety Element describes the City's unique fire risks, including structural fires and wildfires, as well as policies related to emergency response and fire prevention.

4.1.8 Pest Management Resolution

The City's Pest Management Resolution (No. 73968 C.M.S., 1997) identifies that pesticides shall not be used in or on City-owned properties or facilities, with specific exemptions. Exemptions include where use is required to preserve and/or protect human health and safety, around fire hydrants, and on public streets and rights-of-way maintained by the City, amongst others. Certain pesticides (e.g., pesticidal soaps, botanicals, horticultural oils) and also exempted.

4.2 Alameda County

4.2.1 General Plan Scenic Route Element

The Scenic Route Element of the Alameda County General Plan was adopted in 1966 and amended in 1994. It is intended to serve as a means of continuing coordination among the city and county planning functions of Alameda County and the State Division of Highways in the development of a county-wide system of scenic routes, appropriate portions of which would be adopted or expanded upon by each city and the state. The plan is also intended to serve as a guide for development of city and county legislation and programs that will protect and enhance the scenic values along routes.

4.3 State of California

4.3.1 California Public Resources Code

California Public Resources Code Section 4291 (PRC 4291) requires owners of property to create defensible space around structures on their property where firefighters can provide protection during a wildfire. PRC 4291 applies to areas of the state within the responsibility area of CAL FIRE. The defensible space distance is measured along the grade from the perimeter or projection of a building or structure. Under PRC 4291, defensible space is required up to 100 feet from a structure, or to the property limit, whichever is closer; however, the amount of vegetation management necessary may extend beyond 100 feet depending on the flammability of the structure, topography, and fuels. CAL FIRE's Guidelines for Creating Defensible Space as outlined in PRC 4291 can be found at: http://bofdata.fire.ca.gov/PDF/copyof4291final guidelines9_29_06.pdf.

5 MANAGEMENT PLANS AND PROGRAMS

This section describes existing land or resource management plans and programs relevant to vegetation management activity in the Plan Area or the City's VHFHSZ. These plans and programs were consulted during VMP development. This VMP stands independently of these plans and programs but incorporates relevant management recommendations, where applicable.

5.1 City of Oakland Management Plans and Programs

5.1.1 City of Oakland 2016–2021 Local Hazard Mitigation Plan

The Local Hazard Mitigation Plan, adopted June 7, 2016, is intended to assess the risks to the City and to the people of Oakland from natural and human-caused hazards. The Local Hazard Mitigation Plan reviews risks from hazards, including wildfire hazards, identifies mitigation measures to reduce those risks, and presents an implementation program for the next 5 years. The 2016–2021 Plan functions as an appendix to the 2004 Safety Element of the Oakland General Plan, is an update to the 2010–2015 Local Hazard Mitigation Plan, and complements the City's ongoing disaster, emergency, and resilience planning efforts. The City Administrator's office and the OFD's Emergency Management Services Division are responsible for monitoring mitigation measures and annual review of the Local Hazard Mitigation Plan in partnership with staff from the Planning and building Department.

The 2016–2021 Local Hazard Mitigation Plan can be accessed at:

http://www2.oaklandnet.com/government/o/PBN/OurOrganization/PlanningZoning/s/LocalHazardMitigationPlan/OAK058455.

The 2010–2015 Local Hazard Mitigation Plan can be accessed at:

http://www2.oaklandnet.com/oakca1/groups/ceda/documents/report/oak033052.pdf.

5.1.2 City of Oakland Wildfire Protection Assessment District 2011–2014 Vegetation Management Plan

The 2011–2014 Vegetation Management Plan describes the fire prevention codes and ordinances that pertain to WUI/Intermix areas of the City of Oakland, and provides educational information related to wildfire protection to the City's residents. The plan was prepared and enforced by the Wildfire Prevention Assessment District, a City-funded special assessment district active between 2004 and 2017. The District financed the costs and expenses related to vegetation management, yard waste disposal, community wildfire prevention education, and fire patrols in the Oakland Hills. The District has disbanded, and its final meeting was held in June 2017.

5.1.3 City of Oakland Annual Vegetation Management Plan for the Wildfire Protection Assessment District 2006.

The 2006 Annual Vegetation Management Plan describes the fire prevention codes and ordinances that pertain to WUI/Intermix areas of the City of Oakland, and provides information on fire risk reduction activities conducted in the Wildfire Prevention Assessment District and activities planned for 2006.

5.1.4 Oakland Fire Department Vegetation Inspection Program

OFD's Fire Prevention Bureau conducts approximately 26,000 public and private property inspections annually in the VHFHSZ portion of the City. Inspections are mandated by City of Oakland Ordinance No. 11640. The inspection area is divided into five districts (which differ from City Council Districts), each of which has an inspector.

On City-owned and private lots, fire companies and vegetation management inspectors annually inspect properties to identify and notice those that are out of compliance with the defensible space standards outlined in the City's Fire Code (Section 4907 of the Oakland Municipal Code Chapter 15.12). Repeat inspections are made until properties are brought to compliance. The overall annual compliance rate is typically 90%. Rarely does a property reach the level where the work is put out to bid for an independent contractor to complete the work.

The following summarizes the defensible space requirements included in the City's Fire Code:

Developed Lots (lots with a house or other structures):

- Keep a 30-foot minimum defensible space around all buildings (grass, weeds, brush to 6 inches or less).
- Keep 10-foot minimum clearances next to the roadside including street rights-of-way.
- Remove all portions of trees within 10 feet of chimneys or stovepipe outlets.
- Keep roof and gutters free of leaves, needles, or other dead/dying wood.
- Install a spark arrestor on chimneys or stovepipe outlets.
- Remove all tree limbs within six feet of the ground so as not to create fuel ladders.
- Remove dead/dying vegetation from the property.

- Maintain and irrigate all landscaping so it is green.

Vacant lots (if 0.5 acres or less, clear the entire property of flammable vegetation in accordance with fire hazard abatement requirements below. If greater than 0.5 acres, clear the perimeter with a minimum width of 30 feet around the property line or to the exterior boundary of the property):

- Clear entire lot of dry grass, weeds, and brush to a height of 6 inches or less.
- Maintain perimeter clearance of 30 feet within the property line to the exterior boundary.
- Provide a firebreak of l00 feet along the perimeter of property adjacent to neighboring structures.
- Maintain a 10-foot minimum clearance next to the roadside including street rights-of- way.
- Remove dead/dying vegetation from the property.
- Remove all tree limbs within 6 feet off the ground so as not to create fuel ladders.

5.2 Other Related Management Plans and Environmental Documents

5.2.1 Chabot Space and Science Center Vegetation Management Implementation Plan

The Chabot Space and Science Center Vegetation Management Implementation Plan (WRA 2013) was prepared for the City of Oakland to assist efforts in limiting fuel loads at the Chabot Space and Science Center (CSSC). The Plan also assists partial fulfillment of the Pallid Manzanita Habitat Enhancement and Conservation Plan prepared for the CSSC and includes recommendations that would reduce fuel loads and improve habitat conditions for pallid manzanita (*Arctostaphylos pallida*) a plant species federally listed as threatened and state listed as endangered, on the site. The Plan covers approximately 7.93 acres of land to the southwest of the CSSC, and is bounded by the CSSC driveways at the northwest and southeast and by Skyline Boulevard to the southwest.

5.2.2 Chabot Space and Science Center Pallid Manzanita Habitat Enhancement and Conservation Plan

The Pallid Manzanita Habitat Enhancement and Conservation Plan (CSSC 2015) was prepared to fulfill mitigation measures established in the Chabot Space and Science Center 1995 Environmental Impact Report. These mitigation measures were designed to avoid and minimize impacts to pallid manzanita located in the vicinity of the project site. The Plan discusses the existing conditions of the site and habitat for the pallid manzanita, then describes goals and performance standards and habitat enhancement and restoration measures to restore the species to previous numbers at a minimum and protect the plants into the future. The Plan sets forth a monitoring regimen to take place once a year during spring to document the success of habitat enhancement and restoration efforts and to plan future actions.

5.2.3 East Bay Regional Park District East Bay Hills Wildfire Hazard Reduction, Resource Management Plan, and Environmental Impact Report

The East Bay Regional Park District (EBRPD) East Bay Hills Wildfire Hazard Reduction and Resource Management Plan (LSA 2009) was prepared to provide long-term strategies for reducing fuel loads and managing vegetation within EBRPD's Study Area parks. The plan includes wildfire hazard reduction and resource management goals that are further supported by objectives and guidelines to minimize the risk of Diablo wind-driven catastrophic wildfire along the WUI while maintaining and enhancing ecological habitat values within the EBRPD's jurisdiction. In order to achieve these goals, the EBRPD established a vegetation management plan, which describes vegetation types and characteristics within the EBRPD's Study Area, includes fire hazard reduction and resource management goals, and sets forth potential fuel treatment methods. The plan also discusses fuel reduction methods and plan implementation and allows for a feedback process to improve plan implementation.

The Environmental Impact Report (EIR) (LSA 2010) describes the potential environmental consequences that may result from implementation of EBRPD's Draft East Bay Hills Wildfire Hazard Reduction and Resource Management Plan. The EIR is designed to fully inform EBRPD's decision makers, other responsible agencies, and the general public of the plan and the potential consequences of its approval and implementation. The EIR also recommends a set of mitigation measures to reduce or avoid potentially significant impacts and examines various alternatives to the proposed project. The EIR was certified in 2010.

5.2.4 East Bay Municipal Utility District East Bay Watershed Fire Management Plan

East Bay Municipal Utility District (EBMUD) Fire Management Plan guides the implementation of fire protection and preparedness activities that meet key watershed management objectives. Using an integrated GIS-based fire-planning process, the Fire Management Plan can be updated to reflect current scientific information, federal or state regulations, and natural resource constraints. The plan provides a brief history of fire management in the East Bay, describes recent planning and management efforts to enable more proactive fire management practices, and presents fire assessment, fire reduction, and fire management implementation strategies and tactics (EBMUD 2000).

5.2.5 East Bay Municipal Utility District Low Effect East Bay Habitat Conservation Plan

Pursuant to Section 10 of the Endangered Species Act, the EBMUD Habitat Conservation Plan (HCP) specifies the potential impacts of activities associated with the take of listed species occurring in the HCP area. The HCP identifies general and species-specific biological goals, including managing maintenance of existing covered species habitat types and educating EBMUD personnel regarding identification and avoidance of sensitive species. Species goals include providing for covered species individuals and habitats on EBMUD watershed, and working toward general species recovery within the HCP area.

5.2.6 U.S. Fish and Wildlife Service, Recovery Plan for *Arctostaphylos pallida* (pallid manzanita)

Pallid manzanita (*Arctostaphylos pallida*) was listed as endangered by the State of California in 1979, and was federally listed as threatened in 1998 under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.). At the time the species was listed, the U.S. Fish and Wildlife Service (USFWS) determined that designating critical habitat would not benefit the species. The USFWS has since determined that based on the highly restricted range within the San Francisco East Bay and threats unique to the species, a 5-year recovery plan is necessary. The Recovery Plan (USFWS 2015) describes the species, its setting, threats to the species, a recommendation to increase the species from threatened to endangered, and specific measures for recovery.

5.2.7 USFWS, Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area

The Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area (USFWS 1998) covers Presidio clarkia (*Clarkia franciscana*), which is found in the Plan Area. Presidio clarkia was listed as endangered by the State of California in 1978, and was federally listed as endangered in 1995. No critical habitat has been designated for this species. The Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area describes the species, its setting, threats to the species, and recovery strategy. A draft amendment to this document has been published (USFWS 2018), but has not been finalized.

5.2.8 Recovery Plan for the California Red-legged Frog (*Rana aurora draytonii*)

California red-legged frog (*Rana aurora draytonii [=Rana draytonii]*) was federally listed as threatened in 1996. Critical habitat has been designated for this species, but is not present in the

Plan Area. The recovery plan (USFWS 2002) describes the species, its setting, threats to the species, and specific measures for recovery.

5.2.9 Alameda County Community Wildfire Protection Plan

The Alameda County Community Wildfire Protection Plan (CWPP) (Diablo Fire Safe Council 2015) provides an overview of wildfire hazards and risk in the WUI areas of Alameda County, California. The CWPP follows the format established by the federal Healthy Forest Restoration Act by identifying and prioritizing opportunities for fuel reduction within the County, addressing structural ignitability, and including collaboration with stakeholders. The CWPP aims to aid stakeholders in preventing and reducing the threat of wildfire in the County by producing recommendations to increase education about wildfires, reduce hazardous fuels and structural ignitability, and assist emergency preparedness and fire suppression efforts. In order to accomplish this, action plan summaries are provided that identify implementation steps, leaders and partners, timeframes, and funding needs that will occur over several years to facilitate the implementation of mitigation efforts.

5.2.10 CAL FIRE/Santa Clara Unit Strategic Fire Plan

The 2016 CAL FIRE/Santa Clara Unit Strategic Fire Plan (CAL FIRE 2016b) is produced on an annual basis for the coming fire season. The plan includes an assessment of the fire situation in the Santa Clara Unit (which includes Alameda County), stakeholder contributions and priorities, and strategic targets for pre-fire solutions developed by people who reside and work in the local fire problem area. The plan is also designed to achieve the goals and objectives of the 2010 Strategic Fire Plan for California under the direction of the Santa Clara Unit’s pre-fire engineer. After identifying and evaluating existing wildfire hazards, the plan supports collaboration between stakeholders in the implementation and development of actions to reduce potential for a wildfire and ensure adequate response in the event of a wildfire.

5.2.11 Fire Hazard Mitigation Program and Fuel Management Plan for the East Bay Hills (1995)

The Fire Hazard Mitigation Program and Fuel Management Plan (East Bay Hills Vegetation Management Consortium 1995) covers a study area of approximately 37,000 acres from Berkeley to Oakland and summarizes the efforts of nine public agencies to mitigate fire risk, collectively referred to as the Vegetation Management Consortium (VMC). The Plan was funded by grants from the Federal Emergency Management Agency (FEMA) and the California Office of Emergency Services (CalOES) with 50% match by local agencies. The Plan acknowledges the fire risk in the East Bay Hills, summarizes then-current plans and programs, the study area’s fire environment and fire history, identifies high fire hazard areas, and prioritizes fuel treatment areas based on fire hazard ratings. The Plan also identifies vegetation management prescriptions by dominant vegetation type.

5.2.12 Resource Management Plan for the Caldecott Wildlife Corridor

The Resource Management Plan for the Caldecott Wildlife Corridor (Caldecott Corridor Committee 1998) covers the areas of land above the Caldecott Tunnel, a significant habitat linkage across Highway 24. The Plan outlines the ecology, ownership, and fire environment of the study area and outlines management goals and objectives intended to improve wildlife habitat value and reduce wildfire hazard. Recommended management actions are identified in the Plan and are focused on fuel management, habitat restoration, power line management, public education, and road closure.

5.2.13 FEMA Hazardous Fire Risk Reduction Project

The City of Oakland, along with the University of California Berkeley (UCB) and the EBRPD, submitted an application under FEMA's Pre-Disaster Mitigation (PDM) grant program for six vegetation management projects in Alameda County near the Contra Costa County border. The projects included Oakland's North Hills-Skyline-PDM and Caldecott Tunnel PDM projects; UCB's Frowning Ridge-PDM project; and EBRPD's Tilden Regional Park-PDM (Tilden-Grizzly), Sibley Volcanic Regional Preserve-PDM (Sibley Triangle and Island), and Claremont Canyon-PDM (Claremont Canyon-Stonewall) projects. These six project areas total 359 acres and were intended to reduce fire hazard in the area. In its North Hills-Skyline and Caldecott Tunnel projects, the City of Oakland sought to remove eucalyptus and other trees that are prone to torching, preserve non-pyrophytic trees, and create a fuel break on the west side of Grizzly Peak Boulevard north and east of the Caldecott Tunnel. The projects have not been implemented.

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6 PUBLIC ENGAGEMENT

A significant and extensive public and stakeholder engagement effort was conducted to support the development of this VMP. Public engagement activities were conducted with the primary goals of:

- Providing the public with information on the VMP development process; and
- Providing the public with opportunities to provide input and feedback to the City and the VMP development team through meetings, site visits, and the project website where written comments were submitted.

The target audience for the public engagement effort included City of Oakland and Alameda County elected officials, local stakeholder organizations, landowners, immediate neighbors, and the general public. Project fact sheets and presentations were developed to explain the project purpose, need, scope, and location. Project information was distributed via direct emails, letters, social media (Twitter, Facebook), a dedicated project website (https://oaklandvegmanagement .org/), and several public meetings/workshops. Public feedback was collected via email, an online comment form, an online survey, hand-written and verbal comments provided at public meetings, and site visits with stakeholders. Six workshops/meetings were conducted during draft VMP development, as identified below:

- March 29, 2017: Dunsmuir Estate – workshop to introduce the scope and purpose of the VMP and receive public input and feedback
- March 30, 2017: Trudeau Center – workshop to introduce the scope and purpose of the VMP and receive public input and feedback
- June 29, 2017: Trudeau Center – workshop to provide an update on the VMP development process and receive public input and feedback
- May 23, 2018: Oakland City Hall – workshop to present the First Draft VMP and receive public input and feedback

A status update was provided to the City's Safety Council on July 17, 2018. As an outcome of that meeting and direction from the Safety Council, two additional public meetings were held, including:

- November 15, 2018: Trudeau Center - workshop to receive input from the public, and was targeted towards the park steward/volunteer groups working on City-owned parcels
- November 20, 2018: Oakland City Hall – workshop to receive input from the public, and was focused on increased specificity of the VMP.

In addition to these public meetings, additional phone calls, meetings, and on-site meetings were held with stakeholders interested in the VMP to collect additional public input.

The Safety Council directed the VMP development team to conduct more outreach to park volunteer/stewardship groups to receive information on the current activities being conducted in City parks that occur in the Plan Area with the intent of incorporating volunteer/stakeholder input into annual vegetation management planning efforts outlined in this VMP. A summary of park volunteer/stewardship/stakeholder group meetings held in 2019 is summarized below:

- March 22, 2019: Friends of Dimond Park and Knowland Park Adopt-a-Spot. Reviewed site conditions and management recommendations in Dimond Park. Also reviewed site conditions and management recommendations in the northeast portion of Knowland Park and along the frontage road that parallels Skyline Boulevard.
- March 23, 2019: Oakland Landscape Committee. Reviewed site conditions and management recommendations at the North Oakland Regional Sports Field.
- March 29, 2019: Friends of Joaquin Miller Park and Friends of Sausal Creek. Reviewed site conditions and management recommendations at Beaconsfield Canyon and Joaquin Miller Park.
- April 5, 2019: Garber Park Stewards and Claremont Canyon Conservancy. Reviewed site conditions and management recommendations at Garber Park.
- April 6, 2019: Friends of Sausal Creek. Reviewed site conditions and management recommendations at Dimond Canyon and Dimond Park.
- April 12, 2019: Friends and Knowland Park and East Bay Native Plant Society. Reviewed site conditions and management recommendations at Knowland Park.
- April 18, 2019: Friends of Montclair Railroad Trail. Reviewed site conditions and management recommendations at the Montclair Railroad Trail in Shepherd Canyon.
- May 1, 2019: Oak Knoll Neighborhood Improvement Association. Reviewed site conditions and management recommendations at King Estate Open Space Park.
- May 3, 2019: Shepherd Canyon Homeowners Association. Reviewed site conditions and management recommendations at Shepherd Canyon Park.
- May 17, 2019: Coalition to Defend East Bay Forests, Forest Action Brigade, and Hills Conservation Network. Reviewed management recommendations throughout the Plan Area.

All stakeholder and public comments received were catalogued and summarized. Many constructive comments and recommendations helped guide development of this revised draft VMP, including, but not limited to guidance on the following topics:

- Retention of trees and vegetation in treatment areas;
- Prioritization of treatment areas;
- Treatment of weeds, brush, and dead trees;
- Utilization of grazing as a management tool;
- Treatment of vegetation in defensible space areas;
- Protection of natural resources (e.g., streams);
- Removal of eucalyptus and pine species;
- Consideration of Oakland fire history.

Following receipt of public, stakeholder, and park volunteer/stewardship group feedback, and in an effort to refine the prioritization of treatment areas presented in this VMP, additional analysis and fire behavior modeling was conducted to determine which portions of the Plan Area would be subject to extreme fire behavior and thus should be prioritized for treatment. A summary of survey results and key issues raised during VMP development is included in Appendix E.

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7 PLAN AREA RESOURCES

This section summarizes biological, ecological, and community resources found in the Plan Area. Potential impacts to Plan Area resources were considered during development of the vegetation treatment recommendations, BMPs, and the impact avoidance/minimization measures included in this VMP. Potential impacts to these resources will be evaluated further in the VMP's EIR.

7.1 Biological Resources

Special-status (or protected) species are defined as state- and federally-listed Endangered or Threatened species of flora or fauna, and non-listed species otherwise protected by state and/or federal statutes.

7.1.1 Vegetation Communities

As presented in Section 2.3.1, existing vegetation communities and land cover types present in the Plan Area were mapped and classified using the California WHR System (Appendix B). As presented in Table 3, there are 13 vegetation and land cover types mapped in the Plan Area, including coast oak woodland, redwood, valley/foothill riparian, closed-cone pine-cypress, eucalyptus, coastal scrub, mixed chaparral (also known as maritime chaparral), freshwater emergent wetland, perennial grassland, annual grassland, and urban land covers (Appendix B). As the urban WHR classification includes ornamental tree plantings in parks, areas dominated with acacia and mixed trees have been called out separately for this VMP as urban (acacia) and urban (mixed tree stand). Figure 4 presents the distribution of vegetation communities and land covers across the Plan Area.

Urban land cover is present mainly along roads and roadside clearing areas. The Oakland Zoo and Lake Chabot Golf Course are categorized within the urban land cover type. Given the mapping standards under the WHR system, the urban land cover type also includes two vegetated types: acacia tree stands and one acacia/oak/pine/redwood stand that occur in Joaquin Miller Park. These two are noted separately in Table 3. Coast oak woodland is present throughout the Plan Area and is generally located in canyons and on hill slopes. The largest areas of annual grassland are located in the southern portion of the Plan Area, mainly King Estate Open Space Park, Knowland Park, and Sheffield Village Open Space. Quality stands of perennial grassland are intermixed with annual grassland in some areas. Closed-cone pine-cypress vegetation is found in Joaquin Miller Park and surrounding areas, as well as the southern portion of Grizzly Peak Open Space. Eucalyptus vegetation is found in patches throughout the Plan Area, with large areas of this vegetation in the North Oakland Sports Field, Shepherd Canyon, Joaquin Miller Park, and in smaller parcels and roadside clearing areas along Skyline Boulevard. The location of the closed-cone pine-cypress and eucalyptus vegetation types is largely the result of large-scale tree planting that occurred in the Oakland hills between 1880 and 1920 (Nowak 1993). Coastal scrub is located on slopes throughout the Plan Area, with large portions in Grizzly Peak Open Space, Knowland Park, and Sheffield Village Open Space. Redwood vegetation is mainly located in Joaquin Miller Park and nearby Dimond Canyon and Leona Heights Park. Valley/foothill riparian is located along drainages in North Oakland Sports Field and Joaquin Miller Park. Mixed chaparral (also known as maritime chaparral) is located in Knowland Park, near the Oakland Zoo. Finally, small areas of freshwater emergent wetland are located in Garber Park, Joaquin Miller Park, and Knowland Park.

7.1.2 Special-Status Plant Species

As identified in the Biological Resources Report (Appendix B), the following special-status plant species are known to occur in the Plan Area:

- Pallid manzanita (*Arctostaphylos pallida*)
- Oakland star-tulip (*Calochortus umbellatus*)
- Presidio clarkia (*Clarkia franciscana*)
- Western leatherwood *(Dirca occidentalis*)
- Tiburon buckwheat (*Eriogonum luteolum* var. *caninum*)
- Bristly leptosiphon (*Leptosiphon acicularis*)

There are other special-status plants with the potential to occur within the Plan Area but that have not been documented. These plants are presented in the Biological Resources Report (Appendix B). Practices to avoid and/or minimize impacts to sensitive plant species are included in Section 10.

7.1.3 Special-Status Animal Species

As identified in the Biological Resources Report (Appendix B), the following special-status wildlife species have the potential to occur in the Plan Area:

- Western pond turtle (*Emys marmorata*)
- Alameda whipsnake (*Masticophis lateralis euryxanthus*)
- California red-legged frog (*Rana draytonii*)
- White-tailed kite (*Elanus leucurus*)
- Golden eagle (*Aquila chrysaetos*)
- Yellow warbler (*Setophaga petechial*)

- Western red bat (*Lasiurus blossevillii*)
- Pallid bat (*Antrozous pallidus*)
- Western mastiff bat (*Eumops perotis californicus*)
- San Francisco dusky-footed woodrat (*Neotoma fuscipes annectens*)

Practices to avoid and/or minimize impacts to special-status animal species are included in Section 10.

7.2 Streams and Water Resources

The City of Oakland includes many creeks, several flood control channels, and a few lakes, and borders the San Francisco Bay along much of its western edge. Flood control measures and urbanization have altered the hydrologic function and ecology of many of these surface water features. Lake Merritt, Lake Temescal, and Lake Chabot are Oakland's three major lakes, though technically Lake Merritt is a tidal basin with connectivity to the Bay. The San Francisco Bay and Estuary waters provide an important water resource and habitat for marine and terrestrial life, along with other benefits such as scenic and recreational value. The City is committed to the protection of its surface waters and has established several policies to ensure conservation of these resources by retaining creek vegetation, maintaining creek setbacks, controlling bank erosion, and managing City lakes and pollution in the Bay and Estuary (City of Oakland 1996). About 95% of Oakland's drinking water supply comes from Sierra Nevada sources and is managed by the EBMUD. Runoff within local watersheds provides the remainder of the City's supply.

Vegetation in local watersheds and along streams and water courses provides many important functions in protecting water resources and water quality in the watershed. Vegetated riparian corridors may provide water quality buffering benefits to the adjacent streams. Vegetation removal or treatment in riparian corridor areas must be conducted in consideration of potential effects on water quality and ecological function. Riparian vegetation provides habitat for terrestrial and aquatic wildlife species, provides streambank stability, reduces erosion, shades the water surface thereby affecting water temperature (which affects aquatic habitat), and is a source for large woody debris, which falls into streams and watercourses providing habitat and affecting flow patterns and pool development (Kocher and Harris 2007). However, when a watershed is catastrophically burned in an expansive wildfire, many of these functions and roles are lost or severely reduced until the vegetation recovers. Following a catastrophic watershed-wide fire, hillslope erosion and sediment yields through watershed tributary channels typically increase by an order of magnitude (or greater) over non-fire average conditions (Neary et al. 2008). Therefore, sound vegetation management that reduces the extent and frequency of watershed-wide extreme fires also helps avoid and minimize potential sediment and water quality impacts in the watershed. Vegetation management activities seek to maintain the water resource and water quality benefits of watershed vegetation while reducing the hazard and fire risk. Practices to avoid and/or minimize impacts to streams and water resources associated with vegetation management activities are included in Section 10.

7.3 Slopes and Soil Stability

Soil erosion along hillslopes and sediment transport through waterways naturally occurs in the Oakland Hills. These geomorphic processes can be exacerbated and can lead to hazards if aggravated by severe or indiscriminate vegetation removal, increases in impervious surface, alterations of the drainage system, or widespread grading that affects slope stability. The City sets forth policies to protect soils from degradation and misuse due to development. These include soil management practices such as soil enrichment, drainage improvements, covering or creating drainage ditches around exposed slopes during the rainy season, and planting of exposed soils to control erosion (City of Oakland 2012). More than half of the City consists of sloping or hilly land and about one-quarter of the city includes slopes greater than 15%. The Plan Area is entirely within the hill lands of the City. Most of Oakland's soils are considered to have "severe" limitations for development by the U.S. Department of Agriculture. These limitations include steep slopes, shrink-swell potential, and low strength. The presence of three seismically active faults in the vicinity of the City also creates a high risk for earthquakes and landslides within the City. The state's seismic hazard zone maps designate most of the upper Oakland Hills and scattered areas of the lower hills as being susceptible to earthquake-induced landslides. One-quarter of the City has moderate to high potential for landslides. Most landslide activity within the area has been caused by heavy rains, creek channel modifications, and development on steep terrain rather than from earthquakes. The City has established policies to minimize risks associated with landslides and to disseminate outreach and educational materials on measures to reduce slide hazards. Seismic hazard zone maps for the City designate most of West Oakland, North Oakland, and East Oakland as being prone to liquefaction, along with large parts of central Oakland. Subsidence is of low concern within the City (City of Oakland 2012).

Vegetation helps stabilize slopes and minimize soil erosion by providing root strength and by absorbing soil moisture. Plant roots can anchor into bedrock or more stable soils and can bind weaker soils through fibrous root development. Excessive, haphazard, or indiscriminate vegetation removal can result in the loss of root strength in the soil and their decay can increase soil moisture levels, increasing the potential for erosion and slope failure (Ziemer 1981). Vegetation also reduces stormwater runoff by capturing and storing rainfall in the canopy and releasing it releasing it through evapotranspiration. Vegetation also promotes infiltration of rainfall into the soil (Center for Watershed Protection and USFS 2008). Practices to avoid and/or minimize impacts to slopes and soil stability are included in Section 10.

7.4 Community Resources

The City of Oakland includes a unique array of community resources which include buildings, districts, and other features that have significant historic, cultural, educational, architectural or aesthetic interest or value. The City is committed to protecting these resources through policies, goals, and objectives outlined in its General Plan Historic Preservation Element. These resources represent Oakland's rich and multicultural past and include Ohlone archaeological sites, buildings dating from the Spanish-Mexican settlement period, structures from the City's pioneer communities of the early 1860's, Italiante Victorian houses, and development from the 1906 post-earthquake boom. Oakland boasts a diversity of architectural styles including Victorian, Beaux Arts, International, New Brutalist, and modernist styles. The National Register of Historic Places lists 38 properties in the City as historic places, and the Landmarks Preservation Advisory Board designates 113 properties as Oakland landmarks. Oakland includes five preservation districts: Preservation Park, Victorian Row, Preservation Park Extension, Downtown Brooklyn-Clinton, and Portions of the 1900, 2000, and 2100 blocks of 10th Avenue.

Other community resources within the City include the Claremont Hotel and Resort, UC Botanical Garden, Oakland Zoo, CSSC, and Merritt Community College. The Oakland Zoo is within the Plan Area, on City-owned property Knowland Park. The CSSC is in the Plan Area and adjacent to Joaquin Miller Park, and the Claremont Hotel is immediately southwest of Garber Park. Merritt Community College is also within the Plan Area and is adjacent to Leona Heights Park.

The City also includes more than 20 Federal Emergency Management Agency-designated "critical facilities," including fire stations, temporary evacuation shelters, transportation and infrastructure facilities, and other emergency response facilities utilized by the entire San Francisco Bay Area region. The City seeks to preserve these resources by designating eligible properties as historic resources, preserving all City-owned historic properties, and specifying guidelines for alteration to historic properties (City of Oakland 1998).

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8 VEGETATION MANAGEMENT TECHNIQUES

Vegetation management for fire hazard mitigation is the practice of thinning, pruning, removing, or otherwise altering vegetation in order to reduce the potential for ignitions and modify fire behavior. Different vegetation management techniques can be utilized, depending on vegetation type, location, condition, and configuration. Given the dynamic nature of vegetation, a single treatment technique or management prescription may not be appropriate for one site over time. Therefore, an adaptive approach that allows for selection of management techniques is needed to achieve the vegetation management standards outlined in this VMP. Vegetation management techniques will be identified by OFD personnel during annual work plan development and will be dictated by site-specific conditions and effort needed to meet identified vegetation management standards. Vegetation management standards are provided in Section 9.1.

In general, vegetation management techniques can be classified into four categories:

- Biological (e.g., grazing)
- Hand Labor (e.g., hand pulling, cutting)
- Mechanical (e.g., mowing, masticating)
- Chemical (e.g., herbicide)

The following sections present a discussion of each of the vegetation management techniques that may be implemented in the Plan Area, including information regarding equipment, application, timing, limiting factors, special considerations and BMPs. Selection of a qualified and trained contractor, appropriate training, scheduling, and supervision to carry out vegetation management treatments and any associated BMPs are also key components of an effective vegetation management program.

8.1 Biological Techniques

8.1.1 Grazing

Grazing is a method of using livestock to reduce the fine fuel loading of live herbaceous growth, shrubs, and new growth of trees. Livestock, such as cattle, goats, horses, or sheep, browse on grasses, forbs, shrubs, and fresh growth of young trees, thereby removing, over time, any consumed vegetation from the overall fine fuel load of the site. Grazing is effective in managing fine fuels and preventing the expansion of brush/scrub into grasslands. Livestock each have different grazing habits and not all livestock are ideally suited for grazing treatments in all areas. Most livestock, with the exception of goats, do not consume live or dead, tough, woody plant material in any significant quantity as this material is generally unpalatable. Additionally, livestock do not effectively create fuel breaks, but are well-suited to maintain new annual vegetative growth within them. In the Oakland Hills, goat grazing has been successfully used for reducing fine fuel loads in grasslands, brushlands, and beneath tree canopies.


Goat grazing in Grizzly Peak Open Space

To achieve fine fuel reduction standards, grazing typically begins in the late spring, when growth of annual grasses has slowed, and continues through the summer in order to reduce fine fuels prior to the onset of peak fire season. Development of site-specific grazing management plans should be completed for proposed grazing treatments and should include goals and implementation actions to ensure that timing of grazing treatment meets vegetation management standards but minimizes potential negative effects. Grazing management plans should also identify the optimal stocking rate and grazing duration, typically measured in pounds per acre of residual dry matter. Optimal residual dry matter levels should be determined by overall management objectives, such as suppression of weeds, fuel load reduction, or minimizing erosion potential. As a fuel reduction technique, grazing does not need to be conducted each year if the intent is to control shrubs or maintain understory fuels; however, if the intent is to reduce grass or other flashy fuels, grazing should be conducted annually.

Grazing can be a relatively inexpensive and effective treatment method and can even generate revenue when cattle grazing is contracted for large areas. Control of livestock movements and preventing overgrazing is critical for successful implementation. Using professional herders or portable fences may be an alternative to fixed fencing where the treatment is ephemeral. Additional controls may also be needed for protection of retained plants, riparian zones, and sensitive resources areas, and to minimize erosion potential.

8.1.1.1 Grazing Management

Although the concept of grazing is the same regardless of which type of animal is used, how each animal type conducts its grazing varies significantly. As a result, not all animals will be ideally suited for grazing treatments in all areas. Animal selection should be determined by the fuel management standard trying to be reached. As noted, development of site-specific grazing management plans should be completed considering site-specific conditions and identified management standards. The plan should specify management objectives and standards, animal stocking rates and use levels, grazing season (turn-out and turn-in dates), and monitoring requirements and performance criteria. Stocking rates are determined by a range analysis, which calculates the number of animals required for a given period to attain the desired use level, which generally ranges from 600 to 1,000 pounds per acre of residual dry matter, depending on site-specific conditions. The vegetation management standards outlined in Section 9.1 will also help to guide stocking rate and grazing duration.

Fencing installed along roadway for grazing management

Timely movement of livestock to the next treatment area or other available pastures once identified standards have been met is important to minimize potential adverse effects, including soil compaction, overgrazing, and resource damage. Fencing is an important component to grazing management efforts to prohibit livestock from leaving the identified treatment area or gaining access to riparian zones, wetlands, or other sensitive resource areas. Finally, water sources are necessary for livestock and need to be provided if insufficient water is available at the treatment site.

8.1.1.2 Goat Grazing

Specific operational techniques need to be considered for effective fuel reduction by goat grazing. Proper grazing techniques can minimize root impacts. With proper management, goats dramatically reduce the density of brush, but do not eliminate the core plant, which remains alive and viable. Management of goat herd population density is necessary to limit impacts. Maintaining a light population density for a shorter period of time, as well as avoiding localized concentrations of goats helps to reduce soil compaction, retain sufficient plant cover to minimize erosion potential, and reduce animal waste concentrations. Goat grazing also reduces the need for other treatment techniques, although grazing can also be used in combination with such techniques to achieve desired fuel standards. Goats also have the ability to access steeper slopes in an efficient manner. Access to such areas by hand crew increases costs and time necessary for fuel treatment.

Unlike other livestock, goats prefer to browse on woody vegetation (e.g., tree leaves, twigs, vines, and shrubs) and will consume materials up to 6 feet above the ground. This grazing pattern makes goats a desirable choice for fuel reduction treatments as they can effectively create and maintain vertical separation between surface vegetation and the lower limbs of overstory trees (EBMUD 2001). Additionally, substantial amounts of invasive plant seed can effectively be removed from the landscape by the use of time-controlled, short-duration, high-intensity grazing in early spring (Menke 1992). However, since goats will indiscriminately damage most plants, their use in areas with desired shrub and tree retention should be minimized as goats can girdle shrubs and trees by browsing on bark. Alternatively, portable electric fences can be effectively used to control goat herds and more effectively guide the outcome of the grazing effort.

Utilization of goats for achieving the vegetation management standards outlined in this VMP should include development of a grazing management plan for areas selected for grazing during annual work plan development. The plan should provide a range analysis to determine the optimum stocking rate and duration and should include requirements for monitoring to determine when vegetation management standards are attained. Since duration and timing are significant factors in controlling grazing impacts on sensitive plants, goats should be moved once treatment standards are met.

8.1.1.3 History of Grazing in the Plan Area

OFD has historically used goat grazing in portions of the Plan Area to manage vegetation for fire hazard reduction purposes. Approximately 3,000 goats have been utilized annually (typically between May and August) to manage fine fuels on approximately 600 acres to 700 acres of City-owned property, typically on larger City park land and open space. Goats have been used in large treatment areas where manual labor would be cost-prohibitive, to treat vegetation in areas that are inaccessible to mowing equipment, or in areas too steep for hand crews. Areas, such as steep bare hillsides that are prone to erosion, are avoided, and plants identified for retention are protected from goat grazing damage.

Goats are typically used in the following portions of the Plan Area:

- King Estate Open Space Park (approximately 88 acres)
- Joaquin Miller Park (approximately 150 acres)
- Knowland Park (approximately 350 acres)
- Dunsmuir Estates (Sheffield Village Open Space) (approximately 75 acres)
- Shepherd Canyon (approximately 9 acres)
- London Road (approximately 10 acres)

8.1.1.4 Best Management Practices for Grazing

Riparian Zones

Streams and watercourses within proposed grazing areas (e.g., Arroyo Viejo Creek, Shepherd Creek, Palo Seco Creek) should be identified and assessed prior to turn-out. Creek protection zones should be avoided. Limiting exposure of goat herds to water and riparian habitats through temporary exclusion fencing can minimize water contamination risk. The primary concern regarding nutrient and pathogen contamination of water is direct deposit. Unless feces are deposited in or immediately adjacent to a streambed (on the order of a meter or so), there is little danger of significant bacterial contamination from overland flow (Swanson et al. 1994; Buckhouse and Gifford 1976). The creation and use of riparian buffers zones can filter pollutants on slopes up to about 20% and can filter 50% to 90% of the sediment, nitrogen and phosphorus, and bacterial concentrations in surface runoff (EBMUD 2001).

If treatment within the creek protection zone is necessary, those with bank stabilization issues, or associated with unstable side slopes, should be addressed in the grazing plan, and provided additional protection measures. Where creek protection zones are not excluded from the grazing area, the grazing plan should consider the need for retention of streamside vegetation to promote bank stabilization and would require a Creek Protection Permit under Oakland Municipal Code Chapter 13.16 (Creek Protection, Stormwater Management and Discharge Control). The grazing plan should include monitoring the condition of the residual streamside vegetation during grazing activities, and thresholds that trigger turn-in and cessation of grazing prior to denuding the streambank. The grazing plan should also consider the placement location of minerals, such as salt licks, or stock water in relation to the watercourse. Specifying a minimum distance from the watercourse to the mineral or stock water location can help prevent herds from concentrating within the sensitive streamside area.

Sensitive Biological and Cultural Resource Areas

Grazing areas should be assessed for presence of sensitive biological and cultural resources prior to turn-out. Areas with special-status plants, animals, historic or pre-historic resources, and other areas or items of cultural significance, may warrant exclusion from the grazing area, or other protection measures, such as adjusted timing and reduced use levels. Where these areas are not excluded from the grazing area, the grazing plan should identify these areas and the associated protection measures. When special-status biological resources are present, or when management objectives aim to favor a specific biological resource, the timing and use level of grazing practices can often be adjusted to promote plant recruitment. For example, grazing can be timed to occur prior to seed set of annual grasses, which promotes perennial grasses.

Soil Stabilization

Soil types and unstable areas should be identified and assessed prior to turn-out. Grazing areas with soils sensitive to grazing, or with known unstable areas, may warrant exclusion from the grazing area or additional protection measures to enhance soil stability. Where these areas are not excluded from the grazing area, the grazing plan should identify these areas and the associated protection measures, such as adjusted timing and reduced use levels. In areas where sensitive soils or unstable areas are present, timing can be adjusted to avoid grazing during saturated soil conditions, and the use level can be reduced in order to retain additional ground cover.

Highly Flammable/Rapidly Spreading Plants and Pathogens

Measures to prevent the movement and introduction of highly flammable/rapidly spreading plants and diseases should be addressed in the grazing plan, and grazing practices should follow the "Arrive Clean, Leave Clean" approach. The grazing plan should specify requirements for holding areas and quarantine periods for animals prior to turn-out to the grazing area. Stock water should come from an approved source specified in the grazing plan. Additionally, the grazing plan should address sanitation requirements for personnel, equipment, and vehicles.

Other Best Management Practices

Additional BMPs include routine monitoring, proper selection of qualified contractors, inclusion of BMPs in grazing contracts, and properly addressing safety concerns regarding use of electric fences in public spaces.

8.2 Hand Labor Techniques

Hand labor treatments involve pruning, cutting, or removal of trees, shrubs, and grasses by hand or using hand-held equipment. Other hand labor treatments involve bark pulling, removing dead wood and litter, and mulching. Hand labor is most effective for spot application on small areas or areas with difficult access, such as hand-pulling French broom on a small lot, where heavy equipment move-in costs may be high or where topographic or environmental constraints preclude the use of heavy equipment. Hand labor also allows for selective management or removal of targeted vegetation and is typically used in conjunction with other techniques. Hand labor may be dangerous for workers when use of sharp tools is required on steep and/or unstable terrain, or where poison oak, rattlesnakes, or bees are abundant.

Hand labor generates debris when pulling, pruning, and cutting vegetation. If not removed, debris can be chipped or cut down and scattered on site, as long as fuel load standards are met. Requirements for cutting materials into smaller size, known as lopping, does add additional time (and therefore costs) to hand labor techniques. Hand labor techniques typically have lower potential for adverse environmental effects, although large volumes of foot traffic, specifically in areas with steep slopes, can result in surface soil compaction and increase erosion potential.

Hand labor is a treatment technique in which volunteers can assist in hazard reduction activities; required expertise and manual skills vary, however, depending upon the materials treated and equipment required, and appropriate supervision and adequate training is always necessary to ensure desired results.

Hand tools include, but are not limited to, shovels, Pulaski hoes, McLeod fire tools, weed whips (potentially using different blades according to materials being treated) and "weed wrenches" (tools that pull both shrub and root system out), chain saws, hand saws, machetes, pruning shears, and loppers. Personal protection equipment typically includes long pants and long- sleeved shirts, gloves, safety goggles, hard hats, and sturdy boots. Chippers are often used in conjunction with hand labor to process cut materials into mulch for on-site disposal. More common hand labor techniques to reduce fuel loads are described in the following sections.

8.2.1 Line Trimming

Line trimming grass/herbaceous fuels

Line trimming is one of the most common and successful methods for reducing light fuel, flashy loads. This technique uses a hand-held tool (normally gas-powered) that cuts grass, herbaceous vegetation, ground covers, and very small shrubs with a plastic line or cutting blade. Line trimming is typically used after grasses have dried or cured to prevent regrowth in the same year. This technique reduces fuel height and retains the cut material in a compacted layer on the ground surface, minimizing the potential for bare soil. On steep slopes or in areas with retained shrubs/trees, line trimming is more feasible than using mowers. Implementation of this technique should avoid direct contact of the cutting line or blade with the soil surface to minimize disturbance. Trees or shrubs retained within the treatment area should be fenced or otherwise protected from contact with the cutting line or blade to minimize damage to stem tissue. Training crews to work with their back to retained trees or shrubs can also minimize potential damage resulting from cutting line/blade contact.

8.2.2 Branch Pruning/Removal

Hand labor can involve the use of handsaws, chainsaws, pruners, and other equipment to prune shrub or tree branches, remove dead limbs, stems, and branches, and lop larger material into smaller sizes. Fallen branches and cut material can then be further broken into compact mulch and distributed across the site or removed for disposal. While the use of saws and other tools can be a time-efficient option for fuel reduction, pointed stems and branches left behind as a result of tool use may be unsafe in more heavily trafficked areas. Implementation of this technique should avoid cutting and breakage to trees or shrubs retained within the treatment area to minimize damage to stem tissue.

8.2.3 Hand-Pulling and Gathering

Hand pulling weeds

Pulling weeds and gathering downed woody debris, and collecting other combustible materials by hand offers the greatest amount of control among hand labor techniques, prohibits resprouting of weeds by removal of the root system, requires no tools and minimal skill, but is also very time-intensive. Hand pulling of weeds may result in longer-lasting vegetation management compared treatments such as line trimming. Hand pulling weeds and small perennial plants is easiest when soils are near field capacity[7] and roots readily pull out of the ground. Most weeds pulled can be left on site as mulch; however, larger weeds, such as French broom, should be removed. To limit the spread of seeds, care should be taken to bag weeds securely if viable seeds are present. Woody debris may can be staged on site to be chipped, burned, or removed. Other combustible material or trash may be gathered on site for transport to an appropriate disposal facility.

8.2.4 Clearance Pruning

Clearance pruning entails removing understory shrubs, small trees, and small lower tree limbs to create vertical separation between surface fuels and the bottom of the tree canopy. Pruning lower branches of trees can be done with a hand-held pole saw or pole chainsaw. Lower branches on shorter trees may be pruned with loppers. It is recommended that an International Society of Arboriculture-Certified Arborist conduct all pruning according to American National Standards Institute A300 standards (ANSI 2017). Clearance pruning removes fuel ladders and therefore decreases the potential for crown fire transition.

8.2.5 Mosaic Thinning and Dripline Thinning

Mosaic thinning is a treatment technique where trees and shrubs are retained throughout the treatment area in non-uniform patterns. Individual trees and shrubs and/or tree and shrub groupings are thinned to create a mosaic with horizontal spacing established between plants and plant

7 The amount of soil moisture or water content held in the soil after excess water has drained away and the rate of downward movement has decreased.

groupings. Dripline thinning is a technique that involves removing shrubs and/or smaller trees beneath tree canopies to prevent torching and minimize the potential for crown fire transition. Treatment is typically accomplished with chain saws, pruning saws, or loppers. Treated material typically needs to be removed, piled and burned, or chipped and distributed on site. Thinning can reduce fuel continuity and loading by selective removal of vegetation to reach spacing standards. Dead, dying, and pyrophytic plants are prioritized for removal. This technique is most useful in WUI or Intermix areas and/or around high-value resources, such as cultural sites or park management facilities.

8.2.6 Black Plastic Coverage

As an alternative to herbicide use, securing black plastic over cut or treated tree stumps can prevent sprouting by blocking sunlight and thereby preventing latent buds in the remaining tree tissue to germinate. For this treatment type, a 5-millimeter or thicker black plastic sheet is fixed to the top and sides of a cut stump. The plastic can be installed as late as 2 weeks after cutting and requires removal, typically2 years after application. If the plastic is cut, damaged, or torn, reinstallation or other repair and maintenance may be necessary.

Black plastic applied to eucalyptus stumps

Black plastic can also be placed over larger surface areas to prevent germination of weeds; however, this technique also prevents germination of other vegetation. To prevent weed growth, the plastic should be applied prior to active growth, but can be installed after germination. Covering stumps is typically feasible for small areas and treated areas should be checked two to three times a year to make sure that sprouts have not emerged through the plastic or around the edge. Cut stumps may require up to a year or more of covering to prevent resprouting (Holloran et al. 2004).

8.2.7 Mulch Application

The application of mulch, including on-site treated and chipped material, can inhibit weed growth, protect bare soil from rainfall impact, provide soil nutrients during the decomposition process, and help retain soil moisture. For applications where mulch or other chipped material is transported to a site, care should be taken to minimize the spread of plant pathogens (e.g., sudden oak death) or weed seeds that may be present in the material. While mulches can function to reduce weed growth thereby reducing flashy fuels, it should be noted that mulches do burn, although slowly and with low flame lengths; however, they may burn for a longer period of time in one location.

8.2.8 History of Hand Labor Treatment in the Plan Area

OFD has historically used hand labor for managing vegetation throughout the Plan Area, primarily on urban and residential parcels, but elsewhere as needed (e.g., roadsides, small treatment areas within larger parks or open space areas). OFD annually contracts with private contractors to manage vegetation on urban and residential parcels. The use of hand labor is focused on reducing ladder fuels, controlling highly flammable/rapidly spreading species (e.g., broom), reducing surface fuels (e.g., grasses, weeds, down material), thinning vegetation, maintaining fuel loads, and pruning tree canopies. Hand labor is also used in concert with mechanical treatment efforts, when implemented. Areas such as steep bare hillsides that are prone to erosion are avoided, and plants identified for retention are protected.

8.2.9 Best Management Practices for Hand Labor

The following BMPs should be implemented, where feasible, when utilizing hand labor vegetation management techniques. In all circumstances, tools and equipment should be utilized only for their intended use. Additional BMPs are provided in Section 10.

Tool and Equipment Use

- Ensure equipment operators and project personnel are properly trained in equipment use;
- Ensure that vehicles and equipment arrive at the treatment area clean and weed-free;
- Prune trees according to International Society of Arboriculture and American National Standards Institute A300 standards;
- To minimize soil disturbance, leave stumps from removed trees and shrubs intact, with stump heights not exceeding 6 inches, as measured from the uphill side;
- Protect retained trees and vegetation from tool and equipment damage;
- Service and fuel tools only in areas that will not allow grease, oil, fuel, or other hazardous materials to pass into streams or retained vegetation; and
- Remove from the site and properly dispose of all refuse, litter, trash, and non-vegetative debris resulting from vegetation treatment operations, and other activity in connection with vegetation treatment operations.

Fire Safety

During operations that involve the use of any vehicle, machine, tool, or equipment powered by an internal combustion engine operated on hydrocarbon fuels, provide and maintain suitable and serviceable tools for firefighting purposes. Equipment should be located at a point accessible in the event of a fire and should include one backpack pump-type fire extinguisher filled with water, two axes, two McLeod fire tools, and a sufficient number of shovels so that each employee at the operation can be equipped to fight fire. Also ensure that all tools with an internal combustion engine using hydrocarbon fuels is equipped with a spark arrestor, as defined in California Public Resources Code Section 4442.

8.3 Mechanical Techniques

Mechanical techniques include all fuel reduction methods that employ motorized heavy equipment to remove or alter vegetation. Mechanical techniques can be employed to treat grass/herbaceous material (e.g., mowers, diskers), or woody material (e.g., masticators, feller-bunchers). Mechanical treatment techniques rearrange vegetation structures, compact or chip/shred material, and move material to landings, staging areas, or burn piles. Mechanical equipment is usually equipped with either rubber tires or tracks, although skids and cables are also used. In some instances, two or more pieces of heavy equipment will work in concert to achieve the fuel treatment standard. One piece of equipment, such as a feller-buncher, may be responsible for cutting material, while another piece of equipment moves the cut material to a landing or staging area where it can then be further treated or transported off site. Alternatively, one piece of heavy equipment may work independently. For example, mowers leave cut material on the ground surface and masticators shred/chip brush and heavier woody vegetation leaving treated material in a compacted chip layer on the ground surface.

Mechanical equipment is generally used in more uniform fuels where its use more efficiently reaches treatment standards. Constraints to mechanical equipment use include steep slopes, dense tree cover that prohibits travel, saturated soils, and dry, high-fire-hazard weather conditions where equipment use could result in ignition. In addition, selective plant removal is typically not achievable with mechanical equipment (e.g., mosaic thinning) due to equipment size, although equipment can be guided around avoidance areas. Use of mechanical equipment may also result in damage to retained vegetation.

Use of mechanical equipment needs to consider the terrain, access, vegetation type, and treatment standard of the treatment area to effectively treat vegetation and minimize impact potential. Supervision and specialized training are also necessary. The use of mechanical equipment is often done in conjunction with other treatment techniques, particularly hand labor (prior to mechanical treatment) and prescribed fire (following mechanical treatment). As noted below within the description of individual mechanical treatment techniques, the appropriate timing of the treatments plays a large part in determining treatment success. More common mechanical techniques to treat or reduce fuel loads are described in the following sections.

8.3.1 Grading

Grading is typically used to create or maintain firebreaks, creating a strip of land absent of fuel. A tractor with an attached blade can effectively produce a firebreak 8 feet to 12 feet wide with one to two passes. Treatment should be done in the spring months after the ground is dry but before grass is entirely cured. This is done to minimize the potential for equipment-caused ignitions. Grading can have negative effects on surface water drainage where the side banks of the graded area interrupt cross-slope flow. Grading may also accelerate water flow across the graded area. The disturbance created by graded firebreaks can result in establishment of weeds, which should be considered prior to implementing this technique.

8.3.2 Mowing


Mower attachment on a tractor

Mowing tools, such as rotary mowers on wheeled tractors or other equipment, or straight-edged cutter bar mowers, or flails, can be used to cut herbaceous and woody vegetation above the ground. Mowing results in shorter, more compacted fuels, which reduces potential flame length and fire spread rates. Under ideal conditions, approximately 5 acres can be mowed per day, depending on the treatment area's slope and accessibility. Timing of mowing has an impact on the type of grasses promoted. Mowing after annual grasses have cured enhances growing conditions for perennial grasses, provided mowing does not occur during seed production. Mowing at the appropriate time to a height of approximately 4 inches minimizes weed and brush encroachment and reduces the amount of manual work needed to maintain the site. Mowing of weeds is typically required annually. Mowing may be used in conjunction with other techniques, such as disking, to require a thinner strip of disked area. Mowing may not be appropriate in areas where special-status species have potential to occur.

8.3.3 Disking


Disked grassland area (foreground)

Disking is a fuel reduction technique where plant material is cut and mixed with surface soil to create a barrier of discontinuous fuel and bare earth to stop fire spread. This practice is typically used along the perimeter of open spaces, ranches, and roadways. A tractor with disk attachment is used and can typically disk a 15-foot-wide swath in a single pass, disking approximately 2 acres per day. Disking is typically done annually once grass has cured to prevent regrowth during that growing season. Disking creates an uneven surface that reduces water velocity; however, erosion can result, especially in areas with steep slopes. While this treatment is an effective barrier to surface fire spread, it can promote weed growth.

8.3.4 Mechanical Cutting/Crushing

A tractor or similar equipment may be used to crush vegetation using a blade that is kept slightly off the ground. A variety of attachments may also be used, including rollers (e.g., brush hog), a horizontal cutting blade (which operates similar to a large mower), or a set of chains to flail the material being treated. The blade cuts or breaks off the shrub tops, knocks down larger shrubs, and compacts the treated material, which is left to dry so that it can be subsequently scattered or piled and burned. Under this treatment technique, soil is disturbed where the equipment travels and where some shrubs are uprooted. Flailing treatment involves the use of tractors with affixed or towed mowing heads that cut or flail small diameter material, especially grasses. Some attachments include an articulated arm or boom that can reach 10 feet to 15 feet from a vehicle (Tiger mower).


Masticator attachment on a bobcat

Masticating equipment installed on Bobcats, wheeled or crawler-type tractors, excavators, or other specialized vehicles, is used to cut or shred shrubs and trees into small pieces that are then scattered across the ground, where they act as mulch. Shrubs and sapling-size trees are typically masticated with Bobcats and crawler-type tractors, while excavators are often used when larger trees are removed. Bobcats typically operate on slopes with gradients less than 20%, while excavators and tractors can operate on slopes with gradients up to 45%.

Other attachments to tractors and equipment have been developed that use a gravity roller to crush vegetation into mulch. The attachment is held by cables that can be rolled down and winched up a hillside, allowing for some degree of directional aiming through the use of cables at each end. The gravity roller is filled with water to provide the weight necessary to crush the vegetation, and cutting surfaces are arranged on the roller to resemble tire tread. The "Brontosaurus" is a type of grinding machine with an articulated arm that tends to grind off woody material, and in some cases shattering roots of shrubs, more than cutting them.

8.3.5 Chipping

Chipping is often used following other treatment techniques to treat larger cut material and reduces the size of materials by passing them through a series of high-speed blades. The result is chips or mulch, which is deposited into a truck bed or on the ground in a pile or broadcast near the equipment. If retained on site, spreading and redistribution of chipped material is necessary. Spread chipped material on the ground surface results in a compacted fuel structure that is less likely to ignite and carry fire. Larger grinders, such as tub grinders, can chip logs up to 24 inches in diameter.

Chipper

8.3.6 Tree Removal

Tree removal is typically accomplished using chain saws, but may be accomplished with feller-bunchers. Yarding equipment (described below) is then used for transporting cut material to a landing or staging area. Tree removal can be selective (removing individual trees within a stand and retaining others) or broad (removing all trees in a stand or portion thereof). Selective tree removal is used to reduce vertical and horizontal continuity between retained trees and in shaded fuel breaks. The created spacing minimizes the potential for crown fire transition (upward movement of fire from the ground into tree canopies) and crown fire spread (horizontal movement of fire from tree canopy to tree canopy). Broad tree removal is not proposed in this VMP.

Tree being removed in segments

Chain saws are typically used to cut and drop trees to the ground and then de-limb and cut (buck) them into smaller lengths. Feller-bunchers are mechanized pieces of equipment used to harvest or remove trees in a short period of time. Because they tend to be less selective in their application, they are typically not used in areas where tree retention is identified as a treatment standard. While feller-bunchers typically have a 24-inch- to 30-inch-diameter limit for the size of trees that they can remove and can create a large amount of debris requiring removal for further treatment, they generally reduce the amount of skidding and on-site soil disturbance. Following their use, treatment of residual material is typically performed using hand labor techniques.

Tree removal activities require the establishment of a flat landing area, which is an area of land used during operations to sort, store, and load logs onto trucks or to chip them into mulch. Material is yarded to the landing(s), as described below.

8.3.6.1 Yarding

Yarding is the process of transporting cut trees, or portions thereof, from their cut location to a landing or staging area for subsequent treatment or transport off site. Tractor-based yarding involves the use of tractors to pull logs to a landing area where they can be reduced to debris and distributed, or sorted, stacked, and hauled away as logs or chips. Tractor-based yarding on steep slopes can leave significant scars where chains and logs drag along the ground surface, increasing the potential for erosion and compaction and requiring additional treatment to remediate the soil surface. Tractor-based yarding is best suited for flatter areas to minimize the potential for erosion. The use of a feller-buncher in combination with tractor yarding may be appropriate in larger treatment areas; however, the mobilization costs with such equipment may preclude its use on treatment areas less than 5 acres in size.

Cable yarding involves the use of cables to move cut and felled trees to a landing or staging area. Equipment is set up on flat areas and cables strung up or down slopes to transport materials along skid trails. This technique results in less soil disturbance/compaction and therefore less potential for erosion and sedimentation. Cable yarding is preferable on steeper slopes (greater than 35%). The technical layout and machinery used in cable yarding has a sizable effect on the system capabilities. The yarder used should have drums and an interlock system, and should include a mechanical slack pulling carriage, where feasible. These are means by which good control of the logs can be gained. Tractor systems, as described above, may be needed to reduce potential ground disturbance where deflection is insufficient. While compaction and ground disturbance overall should be reduced when using a cable yarding system, there may be spots requiring post-treatment remediation to fill in cuts and gouges in the ground surface to minimize soil erosion potential.

Helicopter yarding uses helicopters to lift and transport trees from the treatment area to landings/staging areas. Helicopter yarding allows for increased selectivity of targeted materials as ground-based crews identify which trees are removed. This technique is suitable in areas with significant slopes. Helicopter yarding requires very large landing areas and equipment and personnel costs can be expensive. Noise impacts resulting from this technique should be evaluated prior to use.

8.3.7 Fire and Fuel Breaks

Firebreaks are areas of land where all vegetation has been removed and bare soil remains, thereby creating a non-burnable area to stop fire spread or facilitate firefighting operations (e.g., backfiring). Responding agencies typically attempt to minimize impacts to sensitive resources when fighting fires in wildlands, and where feasible, fires are allowed to run to natural firebreaks, including trails and roads. These locations may serve as a defensive position for firefighting. Creating firebreaks can have impacts to soil stability, drainage, and weed establishment, as described previously in Section 8.3.1, Grading.


Fire break between oak woodland and chaparral

Fuel breaks, including shaded fuel breaks, are areas of land where vegetation has been treated to slow the spread of a fire or reduce the likelihood of crown fire transition. For fuel breaks in shrub-dominated vegetation types, mosaic thinning is applied to provide horizontal spacing between retained shrubs or shrub groupings. For fuel breaks in tree-dominated vegetation types (shaded fuel breaks), clearance pruning and dripline thinning are applied to provide horizontal and vertical spacing between retained trees and tree groupings and understory vegetation.

8.3.8 Prescribed Fire

Prescribed fires reduce the volume of fuel through combustion and are conducted under specific regulations when conditions permit both adequate combustion and proper control. This technique can be used to burn piles of cut vegetation (pile burns), or over a designated prepared area (broadcast burn). Both broadcast and pile burning are often implemented in conjunction with hand labor and mechanical treatment methods as a means of removing vegetative debris, or in advance of an herbicide treatment to enhance the effectiveness of the application.

Broadcast burns are usually done in larger areas where a maximum amount of fuel treatment can take place and can be used to control noxious weeds and treat cut material (slash) on the ground surface in areas treated by other techniques, or reduce surface and/or ladder fuels beneath tree canopies in shaded fuel breaks. Treatment boundaries are often roads, trails, or other non-burnable features, reducing the number of firebreaks that need to be created. This approach reduces labor costs and preparation time, and minimizes soil disturbance and the potential for soil erosion. Prescribed burns can be used in all vegetation types, where conditions allow for effective control.

Prescribed burning can be a cost-effective way to quickly reduce a large volume of woody material remaining after other fuel treatment operations. A broadcast burn produces more uniform treatment and minimizes areas of great burn intensity. Alternatively, tractors or hand crews can create piles of material on flat or gently sloping ground that can be burned during very wet conditions (pile burn), although the volume of fuel in the piles can produce localized heat which may impact adjacent retained vegetation.


Prescribed fire in grass/shrub vegetation (NPS 2013)

Broadcast burning may occur throughout the year; however, it is usually conducted during the late spring months when the ground is still wet or during fall or winter after plants have completed their yearly growth cycle and their moisture content has declined. Spring burns are sometimes preferred to ensure a greater measure of public safety; however, there may be impacts to animal and plant reproduction. Fall burns are more closely aligned with the natural fire cycle found in California. Piles of vegetation may be burned any time after the vegetation has dried. "Cool" burn prescriptions, using techniques such as backfiring, chevron burning, and flank firing, as well as timing the fires during periods of high humidity and high fuel moisture content, typically results in incomplete combustion; therefore, existing vegetation is partially retained.

Hand held tools, such as drip torches, propane torches, diesel flame-throwers, and fuses (flares), may be used for igniting prescribed fires. Mass ignition techniques may include the use of terra-torches and heli-torches. These types of ignition devices release an ignited, gelled fuel mixture onto the area to be treated. Helicopters may also be used to drop hollow polystyrene spheres containing potassium permanganate that are injected with ethylene glycol immediately before ignition. The sphere ignition method is best used for spot-firing projects in light fuels.

Prescribed burns must be conducted by trained fire protection personnel. Utilizing personnel and equipment from neighboring fire districts provides the added benefit of joint training under prescribed rather than emergency conditions. Timing is critical to the use of this treatment technique due to variances in weather conditions and the necessity to time treatments to minimize impacts to plant and animal species. Fuel moisture content must be determined to assess if the treatment area is safe to burn. There are typically more appropriate burn days in the spring and early summer months when there is a greater chance of atmospheric conditions conducive to smoke dilution and dispersion.

Prescribed burning requires proper planning and the development and approval of a prescription or burn plan, which is typically developed by the local fire protection district in consideration of fuel reduction requirements, local weather conditions, and available resources for fire management. The following sections summarize the planning needs for implementing prescribed burns.

8.3.8.1 Prescribed Fire Tasks

The following describes the steps that must be completed prior to initiating prescribed fire activities.

Burn Plan/Prescription

Working with a fire management specialist, a site-specific prescription and burn plan is developed that establishes goals and procedures for the prescribed burn. This plan takes into account the site characteristics and the likely behavior of the fire, including the heat output, length of burn, best ignition sources and points, and optimal fire control methods. Each characteristic is closely tied to the type, age, density, and condition of vegetation; the site's terrain; solar exposure; and local and prevailing wind patterns. The prescription identifies the limits of the burn area, locations of control lines, acceptable fuel moisture ranges and weather conditions, and required personnel and equipment.

Smoke Management Plan

Local and regional regulating agencies need to review the burn plan to identify potential environmental impacts and develop mitigation measures. The Bay Area Air Quality Management District (BAAQMD) also requires preparation of a smoke management plan detailing the location of sensitive receptors and measures to be implemented to maximize smoke dilution and minimize smoke production. Current air quality regulations within the jurisdiction of the BAAQMD limit open burning; however, burning to reduce fire hazards, for management of forest and rangelands, and to train fire protection personnel receives special accommodation under BAAQMD Regulation 5 (BAAQMD 2013). In addition to the preparation and approval of a smoke management plan, the BAAQMD requires notification of the burn and that burning is conducted on a permissive burn day. The BAAQMD selects burn days based on air quality, weather conditions, and wind patterns; provides the burn's acreage allocation the morning of the burn; and provides the "all clear" designation prior to initiation of the burn.

Pre-burn Site Preparation

Hand labor or mechanical treatment techniques are often conducted prior to initiation of a prescribed burn to remove and treat larger material (trees, shrubs, slash). Treatment of larger material is done to reduce its size and spatial arrangement and to remove ladder fuels that may allow for crown fire transition. Site preparation also includes the establishment of fire lines needed to control the fire if they do not already exist. These fire lines are typically constructed using bulldozers or by hand using scraping tools. Occasionally they are "burned in" with a strip of fire under conditions that limit fire spread.

Burn Notification

Notifying the local or surrounding communities, local fire departments, media, and BAAQMD is an essential component to avoid potential misinterpretation of the prescribed burn as a wildfire. Notification to interested and affected parties and the media are also repeated the day of the prescribed burn. Printed materials or interpretive signs are made available at the site and distributed to neighboring communities explaining the reason for the prescribed burn, the type of burn being conducted, and the intended result of the prescribed burn. Prescribed fires generate high levels of public safety concerns over the chance of fire escape from control lines, and the rapid distribution rate of smoke, ash, and particulate matter may raise additional concerns from the public many miles downwind from the actual burn site.

Post-Burn Follow-up and Evaluation

Following completion of the prescribed burn, the results are evaluated to determine if the need exists for additional treatment based on established goals. Additional treatment methods may include hand labor or mechanical treatment of unburned or partially burned materials. Follow-up and evaluation efforts may occur from 1 to 2 years after the burn to identify needs for additional vegetation treatment or site-remediation needs.

8.3.9 History of Mechanical Treatment Use in the Plan Area

OFD has historically used some of the mechanical techniques identified in the previous sections in portions of the Plan Area to manage vegetation for fire hazard reduction purposes. Mechanical equipment is used on an as-needed basis to grade or disk fire trails, reduce ladder fuels (e.g., small tree removal), control highly flammable/rapidly spreading species, reduce surface fuels (e.g., mowing grasses), chip and spread trimmings and down material, thin vegetation, and maintain fuel loads. OFD has not use prescribed fire (broadcast or pile burning) in the Plan Area due to smoke/air quality permitting requirements. Mechanical techniques are also used in concert with hand labor treatment efforts. Due to mechanical equipment limitations, areas such as steep bare hillsides that are prone to erosion are avoided, and plants identified for retention are protected.

8.3.10 Best Management Practices for Mechanical Techniques

The following BMPs should be implemented, where feasible, when utilizing mechanical vegetation management techniques. In all circumstances, equipment should be utilized only for its intended use. Additional BMPs are provided in Section 10.

Heavy Equipment Use

The following practices should be implemented when using heavy equipment for vegetation management activities:

- Utilize low ground-pressure equipment, to the extent feasible;
- Ensure equipment operators and project personnel are properly trained in equipment use;
- Install waterbreaks as described in Section 10.1 for graded or disked areas that are not otherwise stabilized;
- Ensure that vehicles and equipment arrive at the treatment area clean and weed-free;
- Control fugitive dust resulting from equipment use by watering disturbed areas;
- Protect retained trees and vegetation from potential damage resulting from heavy equipment use;
- To minimize soil disturbance, leave stumps from removed trees and shrubs intact, with stump heights not exceeding 6 inches, as measured from the uphill side;
- Limit the size and quantity of equipment to that which is necessary to meet the identified vegetation management standard;
- Regrade or recontour any areas subject to soil disturbance from heavy equipment, including dragging or skidding of trees or other material;

- Avoid heavy equipment use on unstable slope areas, slopes with gradients exceeding 65%, slopes with gradients between 50% and 65% where the erosion hazard rating is high or extreme, or slopes with gradients over 50% that lead without flattening to sufficiently dissipate water flow and trap sediment before reaching a stream or other water resource. The procedure for determining erosion hazard rating is presented in Section 10.1;
- Service and fuel heavy equipment only in areas that will not allow grease, oil, fuel, or other hazardous materials to pass into streams or retained vegetation;
- Remove from the site and properly dispose of all refuse, litter, trash, and non-vegetative debris resulting from vegetation treatment operations, and other activity in connection with vegetation treatment operations;
- Ensure that hazardous materials spill kits are available on all heavy equipment.

Yarding

For cable yarding, install, operate, and maintain cable lines so that retained trees will not incur unreasonable damage. Retained trees should not be used for rub trees, corner blocks, rigging, or other cable ties unless effectively protected from damage.

Tree Removal

To the fullest extent possible and with due consideration given to topography, lean of trees, utility lines, local obstructions, and safety factors, trees should be felled away from streams, sensitive biological resources areas, and retained trees. Cabling, sectional removal, or other felling techniques should also be employed, where feasible, to minimize impacts to streams, sensitive biological resource areas, and retained trees.

Fire Safety

During operations that involve the use of any vehicle, machine, tool, or equipment powered by an internal combustion engine operated on hydrocarbon fuels, provide and maintain suitable and serviceable tools for firefighting purposes. Equipment should be located at a point accessible in the event of a fire and should include one backpack pump-type fire extinguisher filled with water, two axes, two McLeod fire tools, and a sufficient number of shovels so that each employee at the operation can be equipped to fight fire. Also, ensure that all equipment with an internal combustion engine using hydrocarbon fuels is equipped with a spark arrestor, as defined in California Public Resources Code Section 4442.

8.4 Chemical Techniques

Chemical techniques involve the use of herbicides to kill vegetation or prevent growth and are typically used in combination with other types of fuel reduction treatments. Herbicides do not remove any vegetation from a treatment area; therefore, dead plant material remains unless otherwise treated. Application of herbicides and other chemicals is typically performed by hand, and can include sponging, spraying, or dusting chemicals onto undesirable vegetation. Hand application provides flexibility in application and is ideally suited for small treatment areas. Roadside application of herbicides may employ a boom affixed to or towed behind a vehicle.

Herbicide application requires specific storage, training, and licensing to ensure proper and safe use, handling, and storage. Only personnel with the appropriate license are allowed to use chemicals to treat vegetation. Herbicide application is also only applied per a prescription prepared by a licensed pest control advisor. Personal protection equipment is essential to limit personnel exposure to chemicals, and includes long pants and long-sleeved shirts, gloves, safety goggles, hard hats, sturdy boots, face masks, and, in some instances, respirators.

8.4.1 Herbicides

The application of herbicides may be used on its own or as a secondary vegetation treatment technique following manual (hand labor) or mechanical removal for controlling sprout growth and regeneration. The advantage of herbicide treatments is that they typically result in high kill rates, and can prevent treated plants from setting seed. Thus, in the long run, targeted plants are eliminated as their “seed bank” is eventually eliminated. Some disadvantages include the necessity of applicators to be trained and then licensed by the State of California, the cost of application and safety equipment, the cost of the herbicide itself, the potential to affect non-target vegetation and/or wildlife, and public concern regarding potential health impacts from herbicide use. In spite of these disadvantages, herbicides, or herbicides in combination with hand/mechanical removal, are the most widely used and effective techniques for controlling certain types of vegetation.

Herbicides are broadly classified into two basic types: pre-emergent and post-emergent. Pre-emergent herbicides are sprayed directly onto the ground and prevent plants from germinating and/or growing. As such, they have a larger potential to impact seeds of desired species remaining in the soil, and often have longer persistence times in the environment. Post-emergent herbicides are applied directly onto the plants, often during the early phases of their growth, killing them before they have the chance to mature and set seed. With proper equipment and training, herbicides can be applied selectively, minimizing impacts to seeds of desired species residing in the soil. However, should the target vegetation be intermixed with growing desired vegetation, the chance of affecting desired vegetation would be increased.

Different plants vary in their response to any particular herbicide, and can also vary in their response depending upon in which stage of their life cycle the herbicide is applied. Herbicides applied during the “bolting” phase (when flowing stalks are being produced) may have greater kill rates than the same chemical applied during the rosette stage or the flowering stage. Some herbicides are specific to particular groups of plants (e.g., Fusillade affects only grasses), while others can kill nearly all kinds of plants. Still others are permitted for use in California, while others are not. Systemic herbicides (as opposed to contact herbicides) are likely the most effective for control of highly flammable/rapidly spreading species due to their ability to spread via translocation into root tissue.

Herbicide application should be used following removal of all tree and other perennial species that have the ability to regenerate from root fragments when removal of all plant material is not feasible. Herbicide use should be limited to localized applications rather than foliar applications to eliminate the possibility of drift and impacts to neighboring desirable vegetation. A wide range of herbicides are available for such types of treatment. Herbicide labels and material safety data sheets list susceptible target plant species and provide proper direction in the use and handling of the products. Herbicides should be applied in accordance with state and federal law.

8.4.2 Cut and Daub

Cut and daub treatment is recommended for larger highly flammable/rapidly spreading plants, such as large trees and shrubs, to control regrowth and kill the portion of the plant remaining belowground. Cut and daub involves the cutting of plant stalks or trunks and then the direct application of an appropriate systemic herbicide directly to the cambium layer of the freshly cut stump or stem. Other related methods include drill and fill, where holes are drilled into the trunk of a tree and herbicide is injected, or the glove method, where an herbicide-soaked glove is used to apply directly to plant foliage or freshly cut stumps. It is critical that the herbicide treatment occur immediately after the plants are severed so that the herbicide is carried into the plant tissue. If enough time elapses to allow the cut surface of the severed plant to dry out, a fresh cut should be made prior to herbicide application.

8.4.3 History of Chemical Treatment Use in the Plan Area

On April 5, 2005, the City adopted Resolution 79133 which directed the preparation of the appropriate environmental review documents consistent with CEQA for evaluating a limited exemption to the City’s Integrated Pest Management policy for the selective use of glyphosate (in formulations such as Round-up or Rodeo) and triclopyr (in formulations such as Garlon and Pathfinder) for managing vegetation for wildfire hazard reduction purposes in the City’s VHFHSZ.

No environmental review was completed; therefore, OFD has not used herbicides for vegetation management on City-owned property or along roadsides in the Plan Area.

8.4.4 Best Management Practices for Chemical Techniques

The following BMPs should be implemented, where feasible, when utilizing chemical vegetation management techniques. In all circumstances, equipment should be utilized only for its intended use. Additional BMPs are provided in Section 10.

- Herbicide use should be considered only when other treatment techniques are determined to be infeasible or ineffective in achieving desired management and maintenance standards;
- OFD should consult with a state-licensed pest control advisor and/or the Alameda County agricultural commissioner to identify the appropriate site-specific herbicide application approach to meet vegetation management standards;
- The timing of herbicide applications should be considered to minimize impacts to adjacent retained vegetation and nearby resources (typically between June 15 and November 15, with a potential extension through December 31 or until local rainfall greater than 0.5 inches is forecasted within a 24-hour period from planned application);
- Only herbicides and surfactants that have been approved for aquatic use by the U.S. Environmental Protection Agency and are registered for use by the California Department of Pesticide Regulation should be used for aquatic vegetation control work;
- Herbicide application should be consistent with Federal Insecticide, Fungicide, and Rodenticide Act label instructions and use conditions issued by the U.S. Environmental Protection Agency, California Department of Pesticide Regulation, and the Alameda County agricultural commissioner;
- The lowest recommended rate to achieve vegetation management objectives of both herbicides and surfactants should be utilized to achieve desired control;
- An indicator dye should be added to the tank mix to help the applicator identify areas that have been treated and better monitor the overall application;
- No application to plants whose base is submerged in stream channels should occur;
- Safe procedures for transporting, mixing, and loading herbicides should be followed; and
- The use of foliar (spray) applications should be minimized, prioritizing localized or direct applications.

9 VEGETATION MANAGEMENT AND MAINTENANCE STANDARDS AND AREAS

This section outlines vegetation management and maintenance standards by dominant vegetation type, specific recommendations for key areas, and the procedures for identifying and planning annual vegetation treatment operations. The vegetation treatment techniques presented in Section 8 are the practices and actions used to modify or remove vegetation, while the vegetation management and maintenance standards presented below are the measurable guidelines to achieve the desired vegetation condition to reduce the fire hazard.

9.1 Vegetation Management and Maintenance Standards

Vegetation management for fire hazard reduction is an ongoing, cyclical process. Given the dynamic nature of vegetation, a single management prescription cannot be assigned to any location and be effective in perpetuity. Additionally, management prescriptions intended for initial treatments may differ from those intended for maintenance of the same area. Therefore, the management and maintenance standards presented in this section are derived from the principles of vegetation management for fire hazard reduction and have been broken down by dominant vegetation community/land cover type (grassland/herbaceous, brush/scrub, tree/woodland/forest, and other combustible material). Certain vegetation community/land cover types found in the Plan Area (freshwater emergent wetland and urban) do not present a wildfire hazard due to high moisture levels or noncombustible condition. Therefore, management standards have not been developed for these types of vegetation communities.

This "dynamic approach" allows the vegetation management techniques outlined in the previous section to be selected based on the needs of each management area as conditions change over time. The management and maintenance standards outlined in this section are intended to modify fuel arrangements to reduce the potential for ignitions, rapid fire spread, crown fires, and extreme fire behavior. These standards have been developed to reduce fuel loads, eliminate fire ladders, disrupt the horizontal continuity of vegetation, minimize ignition potential, and prioritize retention of fire-resistant plants.

During annual work plan development, OFD will identify the appropriate vegetation management technique for a given area such that the treatment standards identified below can be achieved. As noted, the application of vegetation management techniques will be influenced by site features (e.g., slope, access, treatment area size) and the condition of vegetation at the time of inspection.

9.1.1 Principles of Vegetation Management to Reduce Fire Hazard

The vegetation management and maintenance standards presented in this section are intended to reduce fire hazard by rearranging and maintaining the spatial distribution of fuels. As noted by Reinhardt et al. (2008), all vegetation will burn, given the right conditions. Therefore, the goal of fuel treatment is not to remove all vegetation, but to minimize the potential for ignitions, crown fires, and extreme fire behavior by reducing fuel loads and altering the structure, composition, and spacing (horizontal and vertical) of retained vegetation. This goal also emphasizes the difference between fuel and biomass. In general, fuels are smaller in diameter, have low fuel moisture content (dead/dying plants or plant parts), are easily ignitable, and facilitate fire spread. Alternatively, biomass is typically larger, healthier vegetation which is retained and provided adequate spacing to minimize potential ignition and fire spread. To achieve this, a combination of methods is necessary and dependent on vegetation type, structure, and condition.

In grass-dominated vegetation types, management is intended to reduce vegetation height (e.g., mowing, grazing) resulting in a shorter and more compact surface fuel layer that is less ignitable and less likely to sustain fire spread. Implemented beneath shrub or tree canopies, such treatments also minimize the potential for surface to crown fire transition. Management is also intended to maintain low fuel volumes in the land areas between shrub- and tree-dominated vegetation types.

In shrub-dominated vegetation types, management is intended to reduce surface fuel loading and flame lengths and slow fire spread by increasing the horizontal spacing between retained shrubs. In areas beneath trees, management is also intended to increase the vertical spacing between shrub and tree canopies to reduce the potential for surface to crown fire transition. Removal or treatment (e.g., chipping) of dead material from shrub-dominated types also reduces dead fuels loads, can assist in reaching spacing standards, and helps minimize the growth of highly-ignitable grass/herbaceous vegetation.

In tree-dominated vegetation types, management is intended to increase the horizontal spacing between retained trees to reduce the potential for crown fire spread. It is also intended to remove fuel ladders by increasing the vertical spacing between surface fuels (shrubs, grasses) and tree canopies to reduce the potential for surface to crown fire transition. Creating more fire resilient tree stands involves a three-part process of reducing surface fuels, reducing ladder fuels (i.e., fuel that can facilitate fire spread from ground fuels into tree crowns), and reducing tree crown density through crown thinning (USFS 2013). As noted by Nunamaker et al. (2007), surface and ladder fuels should have the highest priority for management to reduce fire intensity, rate of spread, and crown fire potential. Active crown fires are initiated with torching, but are ultimately sustained by the density of the overstory crowns. Reduction in potential surface fire behavior plus an increase in canopy base height minimizes torching potential (Agee and Skinner 2005).

Canopy thinning via selective removal of trees within a stand can achieve desired horizontal spacing between retained tree canopies to minimize potential crown fire spread. Thinning from below, a technique in which trees are removed from the lower forest/stand canopy, can reduce the severity and intensity of wildfires by reducing crown bulk density and increasing crown base height (Graham et al. 1999). Thinning or removal of overstory trees can result in higher mid-flame wind speeds and decreased fine fuel moisture, which can increase surface flame lengths, resulting in crown fires and increased fire intensities. However, sufficient treatment of surface fuels (understory, slash, and ladder fuels) results in a reduction in fire behavior sufficient to outweigh these effects (Graham et al. 1999; Agee and Skinner 2005). As described below in Section 9.1.4, one goal of these treatments is to create stand conditions that function as a shaded fuel break. Table 8 summarizes the effects and advantages associated with fuel management in tree-dominated vegetation types.

Table 8
Principles of Fire Resistance to Tree-Dominated Vegetation Types

Principle	Effect	Advantage	Concerns
Reduce surface fuels	Reduces potential flame length	Control easier; less torching	Surface disturbance less with fire than other techniques
Increase height to live crown	Requires longer flame length to begin torching	Less torching	Opens understory; may allow surface wind to increase
Decrease crown density	Makes tree-to-tree crown fire less probable	Reduces crown fire potential	Surface wind may increase and surface fuels may be drier
Keep big trees of resistant species	Less mortality for same fire intensity	Generally restores historic structure	Less economical; may keep trees at risk of insect attack

Source: Agee and Skinner 2005

Another important factor in any vegetation management plan is the lifespan of fuel treatments (Reinhardt et al. 2008). Given the dynamic nature of vegetation, especially in the Plan Area, maintenance and routine annual treatment of vegetation is a critical component for managing wildfire hazard. The vegetation management and maintenance standards outlined in this section are intended to be implemented over the life of this VMP, as outlined in Section 9.3, Property Assessment, Identification of Treatment Needs, and Work Plan Development.

9.1.2 Grassland/Herbaceous

This section outlines management and maintenance standards for grasses; other light, flashy fuels; and surface fuels capable of igniting and carrying fire. Grassland/herbaceous fuels in the Plan Area are composed of the annual grassland and perennial grassland vegetation community/land cover types. As described in Appendix B, perennial grassland mapped in the Plan Area is characterized by perennial grass species, including purple needlegrass (*Stipa pulchra*), foothill needlegrass (*S. lepida*) and blue wildrye (*Elymus glaucus*). Grass, other light, flashy, or surface fuels may be found within other mapped vegetation communities/land cover types and should be treated to the standards outlined in this section. The following management standards shall apply to grass/herbaceous fuels:

- Within 30 feet of a habitable structure (within or outside of City-owned property), grasses (annual and perennial), weeds, and thistles shall be treated such that heights do not exceed 3 inches. Avoid removal to the mineral soil to minimize erosion;
- Beyond 30 feet from a habitable structure, grasses (annual and perennial), weeds, and thistles shall be treated such that heights do not exceed 18 inches, but it is recommended to cut grasses below 6 inches in height;
- Cut grass may be left on the ground surface to protect soil as long as it does not exceed 6 inches in height;
- All dead or dying ground cover, vines, or other surface vegetation shall be removed or chipped and spread on site;
- All dead twigs, branches, or limbs from overstory shrubs and/or trees shall be removed or treated (e.g., chipped) and spread as a ground cover (mulch) on site;
- All mulch or chipped material shall be spread to a depth not to exceed 6 inches; and
- All material removed from the site shall be properly disposed of per City standards.

9.1.3 Brush/Scrub

This section outlines management and maintenance standards for brush/scrub vegetation. Brush/scrub fuels in the Plan Area are composed of the mixed chaparral and coastal scrub vegetation community/land cover types. Brush/scrub vegetation is typically characterized by relatively open to dense woody shrub cover and may include some scattered trees or clusters of trees. Brush/scrub fuels may be found within other mapped vegetation communities/land cover types and should be treated to the standards outlined in this section. The following management standards shall apply to brush/scrub fuels:

- All dead brush/scrub shall be removed;
- All dead and dying growth shall be removed from brush/scrub;
- Individual shrub crowns shall be horizontally separated from adjacent shrubs, shrub groupings, or trees by at least two times the height of the shrub crown. Groupings of shrubs may be retained such that the grouping does not exceed 8 feet in diameter. Shrub groupings shall be horizontally separated from adjacent shrubs, shrub groupings, or trees by at least two times the height of the shrub crown;

- Where brush/scrub is located within the dripline of an individual, isolated tree or small tree grouping, the vertical separation between the top of the shrub and the lowest tree branch shall be at least three (3) times the height of the shrub crown or 8 feet, whichever is greater;
- Individual, isolated pyrophytic trees located within brush/scrub stands shall be prioritized for removal;
- To minimize soil erosion potential, removed shrubs shall be cut at or near the ground surface and root systems left intact;
- All vegetative material from brush/scrub removal or trimming shall be removed or treated (e.g., chipped) and spread on site;
- All chipped material shall be spread to a depth no greater than 6 inches;
- All material removed from the site shall be properly disposed of per City standards; and
- When brush/scrub removal is necessary to achieve the spacing standards outlined above, removal of pyrophytic plants shall be prioritized over fire resistant plants.

9.1.4 Tree/Woodland/Forest

This section outlines management and maintenance standards for tree-dominated vegetation types. Tree/woodland/forest fuels in the Plan Area are composed of the coast oak woodland, closed-cone pine-cypress, eucalyptus, redwood, valley/foothill riparian, urban (acacia), and urban (mixed tree stand) vegetation community/land cover types. Tree-dominated vegetation in the Plan Area varies from relatively open tree stands to dense stands with relatively closed canopy cover. Trees or small clusters of trees may be found within other mapped vegetation communities/land cover types and should be treated to the standards outlined in this section. The general management standards outlined below shall apply to all tree-dominated fuel types and are intended to create stand conditions that function as a shaded fuel break. A shaded fuel break is constructed in a forest setting where the tree canopy is thinned to reduce the potential for a crown fire to move through the canopy and understory vegetation is likewise thinned. The shade of the retained canopy helps reduce the potential for rapid re-growth of shrubs and sprouting hardwoods and can reduce erosion (CAL FIRE 2019b). Type-specific standards providing additional clarification are included in subsequent sections.

9.1.4.1 General Standards

The following management standards shall apply to all tree-dominated fuel types:

- All dead trees shall be removed;

- All dead/dying growth and litter shall be removed from trees per Oakland Fire Code Section 4907.3.1.4;
- Portions of tree crowns extending to within 10 feet of any structure shall be pruned to maintain a minimum horizontal clearance of 10 feet;
- Portions of tree crowns that extend within 10 feet of the outlet of a chimney shall be pruned to maintain a minimum horizontal clearance of 10 feet;
- Portions of tree crowns above roads shall be pruned to maintain 13.5 feet of vertical clearance above the road surface (Oakland Fire Code Section 4907.5);
- Trees within 100 feet of habitable structures shall be pruned to remove limbs located less than 6 feet above the ground surface (Oakland Fire Code Section 4907.3.1.3);
- Where brush/scrub is located within the dripline of a tree, the vertical separation between the top of the retained shrubs and the lowest tree branch shall be at least three (3) times the height of the retained shrub crown or 8 feet, whichever is greater;
- To minimize soil erosion potential, stumps from removed trees shall be left intact, with stump heights not exceeding 6 inches (as measured from the uphill side);
- All vegetative material from tree removal or trimming shall be removed or treated (e.g., chipped) and spread on site (where necessary for erosion control, logs no smaller than 8 inches in diameter [small end] may be retained on the soil surface);
- All chipped material shall be spread to a depth no greater than 6 inches;
- Where they exist, trail networks shall be maintained to facilitate access and to create breaks in surface fuels;
- All material removed from the site shall be properly disposed of per City standards; and
- When tree removal is necessary to achieve identified spacing standards, removal of pyrophytic plants shall be prioritized over fire-resistant plants.

9.1.4.2 Specific Standards

The overall intent of the management and maintenance standards for tree/woodland/forest included in this section is to reduce densities by thinning stands, promote retained tree trunk diameter growth, promote retained tree health by reducing competition, retain ground surface shading through canopy retention, retain fire-resistive species, and provide horizontal separation to minimize the potential for crown-to-crown fire spread. The result of treatment in these vegetation types would be a shaded fuel break, as described above. In addition to the general standards for tree/woodland/forest vegetation community/land cover types identified above, the following management standards shall apply to specific tree-dominated vegetation types. The specific standards presented below shall override general standards should conflicts exist.

- **Eucalyptus:** Eucalyptus stands in the Plan Area include two primary types: mature and second-growth. Mature stands are those that have not been cut and typically have larger, single-stem trees with understories consisting of seedling/sapling eucalyptus trees, annual grasses, and eucalyptus tree litter (leaves, branches, limbs, and streamer bark). OFD currently manages many of the mature eucalyptus stands in the Plan Area to treat understory surface fuels. Second-growth stands are those that have been previously cut or are characterized by their re-sprout growth form—multiple smaller stems (trunks) originating from the cut stump (e.g., trees re-sprouted following the 1970-1971 freeze). This growth form contributes to increased fire risk by creating dense, lower-growing canopies with reduced vertical clearance from surface fuels (ladder fuels). The primary second-growth stand present in the Plan Area is located at the North Oakland Regional Sports Field property. OFD does not currently manage the interior of this stand. A discussion of fuel loading and the fire hazard presented by eucalyptus stands is presented in Section 2.3.2. The following management standards apply to eucalyptus vegetation communities/land cover types:
  - Thin mature eucalyptus stands to reach an average 35-foot horizontal spacing between trunks. This results in a post-treatment stand density of approximately 36 trees per acre. Prioritize retention of healthy trees and remove all single-stem eucalyptus with trunk diameters measuring less than 8 inches;
  - Thin second-growth eucalyptus stands to reach an average 25-foot spacing between trunks. This results in a post-treatment stand density of approximately 108 trees per acre. Treat retained trees by removing all but one, single dominant stem (trunk). Prioritize retention of healthy trees and remove all single-stem eucalyptus with trunk diameters measuring less than 8 inches;
  - Where small trees, shrubs, grasses, highly flammable/rapidly spreading species, and/or eucalyptus seedlings/saplings/sprouts exist beneath tree canopies (surface fuels), the vertical separation between the top of surface fuels and the lowest tree branch shall be at least three (3) times the height of the surface fuels or 8 feet, whichever is greater. Where duff, mulch, or bare soil exists beneath tree canopies, provide at least 8 feet of vertical clearance between the lowest tree branch and the duff/mulch/soil surface;
  - Remove loose/stringy bark from retained individual eucalyptus trees up to a height of 8 feet to minimize crown fire transition (consistent with the Oakland Fire Code Section 4907.3.1.4);

- Implement treatment techniques to control sprout growth from cut stumps;
- Maintain duff layer at a depth no greater than 6 inches; and
- Prioritize retention of City protected and non-pyrophytic trees existing in eucalyptus stands and incorporate them into the tree spacing standards identified above.
- Remove highly flammable species identified in Appendix D where they are found in this vegetation type. These species can contribute to increased fuel loads and fire hazard, if not managed. The Weed Workers' Handbook (Appendix F) provides management techniques and BMPs for treating these species and should be followed when managing these species in the Plan Area.

- **Closed-Cone Pine-Cypress:** Pine stands (primarily Monterey pine) in the Plan Area primarily occur as mature, often dense stands and are often mixed with other tree species (eucalyptus (*Eucalyptus spp.*) or Monterey cypress (*Cupressus macrocarpa*)). Open stands exist and tend to have a well-developed understory of oaks, California bays, poison oak, and blackberry. Scattered individual pines are also found within other vegetation communities/land cover types. A discussion of fuel loading and the fire hazard presented by pine stands is presented in Section 2.3.2. The following management standards apply to closed-cone pine-cypress vegetation communities/land cover types:
    - Thin mature pine or cypress stands to reach an average 30-foot horizontal spacing between trunks. This results in a post-treatment stand density of approximately 48 trees per acre. Prioritize retention of healthy trees and remove all single-stem pines and cypress with trunk diameters measuring less than 8 inches;
    - Where small trees, shrubs, grasses, invasive species, and/or pine/cypress seedlings/saplings exist beneath tree canopies (surface fuels), the vertical separation between the top of surface fuels and the lowest tree branch shall be at least three (3) times the height of the surface fuels or 8 feet, whichever is greater. Where duff, mulch, or bare soil exists beneath tree canopies, provide at least 8 feet of vertical clearance between the lowest tree branch and the duff/mulch/soil surface;
    - Maintain duff layer at a depth no greater than six (6) inches; and
    - Prioritize retention of City protected and non-pyrophytic trees existing in pine stands and incorporate them into the tree spacing standards identified above.
    - Remove highly flammable species identified in Appendix D where they are found in this vegetation type. These species can contribute to increased fuel loads and fire hazard, if not managed. Appendix F provides management techniques and BMPs for

treating these species and should be followed when managing these species in the Plan Area.

- **Urban (Acacia) and Urban (Mixed Tree Stand):** Acacia trees (*Acacia spp.*) (primarily blackwood acacia) in the Plan Area primarily occur as mature, often dense stands or shrub-like thickets and are also mixed with other tree species (oak, redwood, eucalyptus). Scattered individual acacia trees are also found within other vegetation communities/land cover types. A discussion of fuel loading and the fire hazard presented by acacia trees is presented in Section 2.3.2. The following management standards apply to the urban (acacia) and urban (mixed tree stand) vegetation communities/land cover types:
  - Thin acacia-dominated stands to reach an average 35-foot horizontal spacing between trunks. This results in a post-treatment stand density of approximately 36 trees per acre. Prioritize retention of healthy trees;
  - Where small trees, shrubs, grasses, other invasive species, and/or acacia seedlings/saplings/sprouts exist beneath other mature, tree canopies, the vertical separation between the top of surface fuels and the lowest tree branch shall be at least three (3) times the height of the surface fuels or 8 feet, whichever is greater. Where duff, mulch, or bare soil exists beneath tree canopies, provide at least 8 feet of vertical clearance between the lowest tree branch and the duff/mulch/soil surface;
  - Implement treatment techniques to control sprout growth from cut stumps;
  - Maintain duff layer at a depth no greater than 6 inches; and
  - Prioritize retention of City protected and non-pyrophytic trees existing in urban (acacia) and urban (mixed tree stand) vegetation types and incorporate them into the tree spacing standards identified above.
  - Remove highly flammable species identified in Appendix D where they are found in this vegetation type. Appendix F provides management techniques and BMPs for treating these species and should be followed when managing these species in the Plan Area.
- **Oak Woodland:** Coast oak woodland in the Plan Area includes a mix of tree species such as coast live oak, California bay, buckeye (*Aesculus californica*), interior live oak (*Quercus wislizeni*), canyon live oak (*Q. chrysolepis*), and madrone (*Arbutus menziesii*). Less dense stands with relatively open canopies may include grass or brush/scrub understories, while dense stands with closed canopies typically include only duff or leaf litter in the understory. A discussion of fuel loading and the fire hazard presented by oak woodlands is presented in Section 2.3.2. The following management standards apply to oak woodland vegetation communities/land cover types:

- In mature, closed-canopy oak woodlands with duff/leaf litter understories, the vertical separation between the top of surface fuels and the lowest tree branch shall be at least 3 feet. Where such stands abut brush/scrub vegetation communities/land cover types, provide horizontal spacing between the outward oak canopy edge and the nearest shrub equal to three (3) times the adjacent shrub height;
- In more open oak woodlands with brush/scrub or grass understories, the vertical separation between the top of surface fuels and the lowest tree branch shall be at least three (3) times the height of the surface fuels. Encourage development of a dense tree canopy by prioritizing removal/treatment of understory shrubs/grass rather than pruning tree canopies;
- Maintain duff layer at a depth no greater than 3 inches;
- Remove individual eucalyptus, pine, or acacia trees from within oak woodlands; and
- Remove highly flammable species identified in Appendix D where they are found in this vegetation type. Appendix F provides management techniques and BMPs for treating these species and should be followed when managing these species in the Plan Area.

- **Redwood:** Redwood vegetation communities/land cover types present relatively low fire hazard. Redwood forests in the Plan Area typically have dense canopy cover. A discussion of fuel loading and the fire hazard presented by redwood vegetation communities is presented in Section 2.3.2. The following management standards apply to redwood vegetation communities/land cover types:
  - In mature, closed-canopy redwood stands with duff/leaf litter understories, the vertical separation between the top of surface fuels and the lowest tree branch shall be at least 3 feet. Young redwood crown sprouts and sapling growth should be thinned to achieve this standard. Where such stands abut brush/scrub vegetation communities/land cover types, provide horizontal spacing between the outward oak canopy edge and the nearest shrub equal to three (3) times the adjacent shrub height;
  - In more open redwood stands where small trees, shrubs, grasses, invasive species, and/or redwood seedlings/saplings exist beneath tree canopies (surface fuels), the vertical separation between the top of surface fuels and the lowest tree branch shall be at least three (3) times the height of the surface fuels. Encourage development of a dense tree canopy by prioritizing removal/treatment of understory shrubs, grass, or young redwood crown sprouts/seedlings rather than pruning tree canopies;
  - Young redwood crown sprouts and sapling growth should be thinned. Retain three (3) sprouts (trunks) per stump;

- Maintain duff layer at a depth no greater than 3 inches; and
- Remove individual eucalyptus, pine, or acacia trees from within redwood vegetation communities;
- Remove highly flammable species identified in Appendix D where they are found in this vegetation type. Appendix F provides management techniques and BMPs for treating these species and should be followed when managing these species in the Plan Area.
- Maintain closed tree canopy to shade out understory ladder fuels.

- **Riparian:** Similar to redwood forest, riparian vegetation communities/land cover types present relatively low fire hazard due to year-round high moisture levels. Riparian forests in the Plan Area typically have dense canopy cover and are located along creeks and drainages. A discussion of fuel loading and the fire hazard presented by riparian vegetation communities is presented in Section 2.3.2. The following management standards apply to riparian vegetation communities/land cover types:
  - Minimize vegetation management activities in riparian areas and target the removal/treatment of downed tree and leaf litter material outside of the stream channel;
  - Target ladder fuel treatment at the edge of riparian woodlands where they abut other vegetation communities/land cover types. In these areas, the vertical separation between the top of surface fuels and the lowest tree branch shall be at least 3 feet. Provide horizontal spacing between the outward canopy edge and the nearest shrub equal to three (3) times the adjacent shrub height;
  - Remove highly flammable species identified in Appendix D where they are found in this vegetation type. Appendix F provides management techniques and BMPs for treating these species and should be followed when managing these species in the Plan Area.
  - Maintain closed tree canopy to shade out understory ladder fuels.

9.1.5 Other Combustible Material

Other combustible material, including, but not limited to, debris, trash, or yard waste that is placed, left, or deposited in the Plan Area should be removed or chipped and spread according to the standards outlined above. Any material removed from the Plan Area should be properly disposed of per City standards.

9.2 Current and Recommended Treatments for Specific Areas

Urban/residential parcel – eucalyptus stand with treated understory

The previous sections identified vegetation management standards by dominant vegetation type. Given the variability of site characteristics and parcel sizes across the Plan Area, general recommendations and site-specific projects are warranted for some areas, or portions thereof, as presented in the following sections. The City-owned parcels and roadsides in the Plan Area have been categorized based on size, location, and similar characteristics, as summarized in the following sections. The following sections also summarize existing vegetation management activities being implemented by the City along with vegetation management actions and projects recommended under this VMP. This section also includes references to priority treatment areas (Priority 1, 2, and 3), which are defined in Section 9.3.3 and shown in Figures 6.1 through 6.10. A visual analysis of recommended treatments for select areas was conducted, with the results presented in Appendix G. The role of volunteer and stewardship groups in managing vegetation in City parks is addressed in Section 11.2. Finally, detailed vegetation type acreages and implementation and maintenance costs for identified projects are presented in Appendix H.

9.2.1 Urban and Residential Parcels

Urban and residential parcels are those which are generally smaller than 1 acre in size and are distributed throughout the Plan Area. In some cases, multiple adjacent parcels are owned by the City. Urban and residential parcels are mapped as the following vegetation communities/land cover types: annual grassland (2.4 acres), closed-cone pine-cypress (8.9 acres), coastal oak woodland (18.4 acres), coastal scrub (2.4 acres), eucalyptus (10.7 acres), redwood (0.2 acres), urban (7.9 acres), and urban (acacia) (0.2 acres). Current management practices for these parcels includes manual treatment of vegetation, often under contract to private contractors. Current vegetation management on these parcels is focused on reducing ladder fuels, controlling invasive species (e.g., broom), reducing surface fuels (e.g., grasses, weeds, down material), maintaining fuel loads, and pruning tree canopies through the use of hand labor or mechanical techniques.

Grazing has also been conducted on urban and residential parcels, primarily where multiple City-owned parcels abut each other, creating a larger area for treatment.

All urban and residential parcels fall entirely or largely within the 100-foot buffer from existing structures and are therefore considered **Priority 1** treatment areas (as defined in Section 9.3.3). It is recommended that these parcels continue to be maintained according to the standards outlined in Section 9.1. Table 9 summarizes the quantity, size, and acreage of the urban and residential parcels in the Plan Area. The locations of urban and residential parcels are presented in Figures 5.1 through 5.10.

Table 9
Urban and Residential Parcels within the Plan Area

Parcel Size	Quantity	Total Acreage
<0.1 acres	34	1.2
0.1 to 0.5 acres	90	19.0
0.5 to 1.0 acres	15	10.2
1.0 to 1.5 acres	7	8.4
1.5 to 2.0 acres	3	5.4
2.0 to 2.1 acres	3	7.0
Total:	**152**	**51.2**

The following specific project has been identified for Urban and Residential Parcels:

- **URB-1:** Maintain vegetation within the entirety of all urban and residential parcels according to the standard outlined in Section 9.1. Treatment area equals 47.5 acres, accounting for non-vegetated areas within urban parcels. **Priority 1**.

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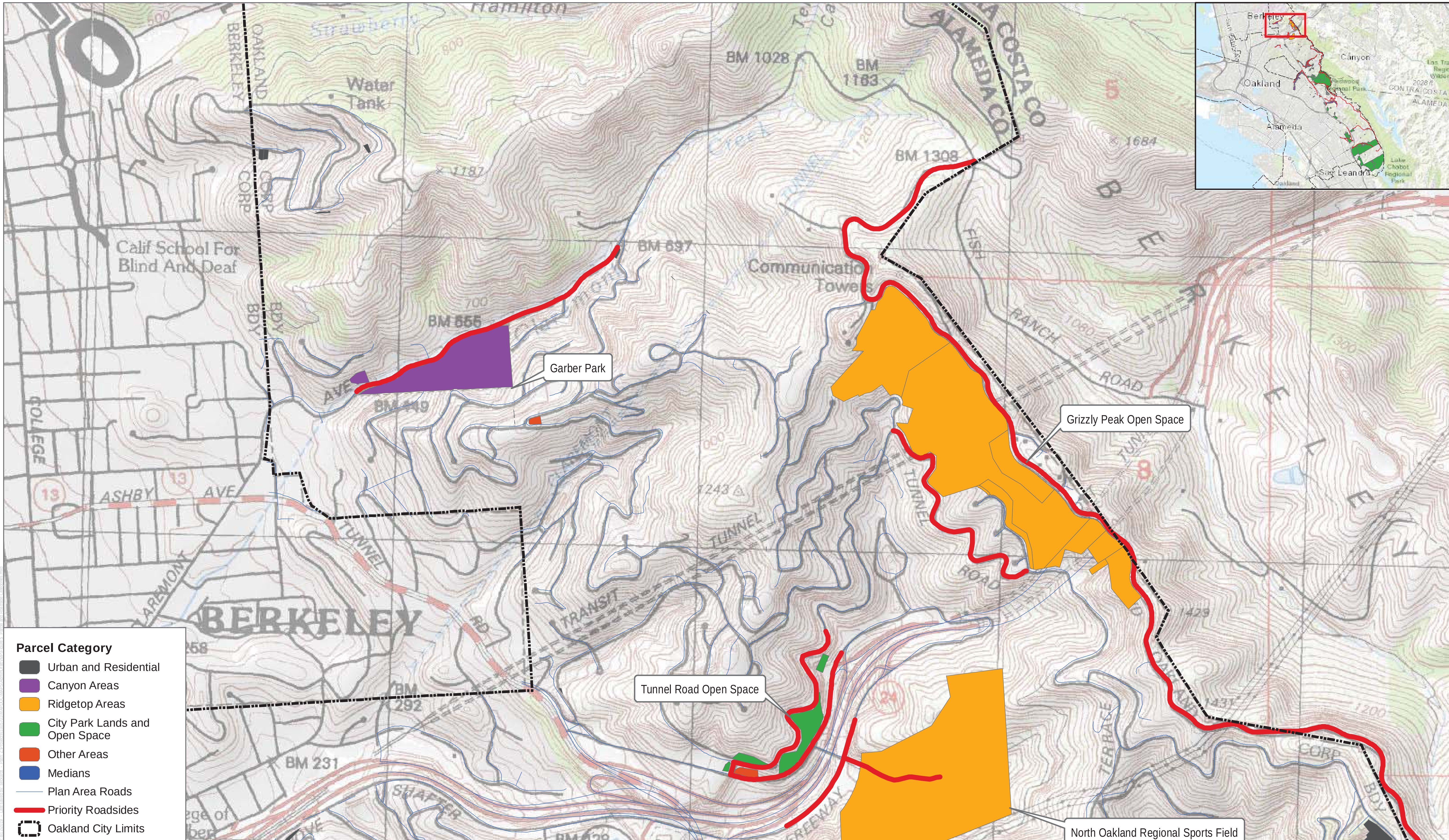

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

DUDEK

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FIGURE 5.1

City-owned Parcel and Roadside Categories

Revised Draft Vegetation Management Plan - City of Oakland, California

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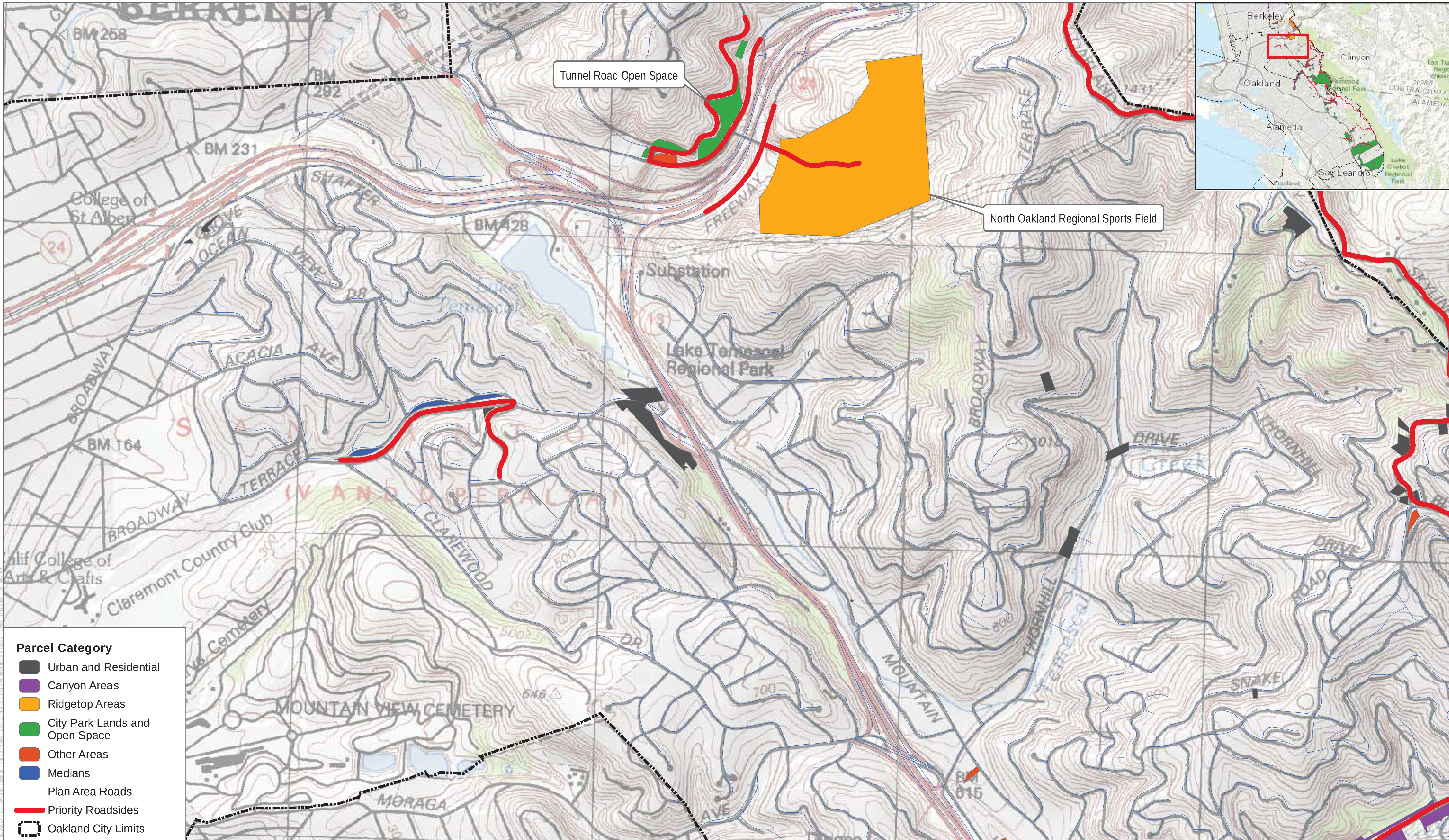

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 5.2

City-owned Parcel and Roadside Categories

Revised Draft Vegetation Management Plan - City of Oakland, California

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SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 5.3

City-owned Parcel and Roadside Categories

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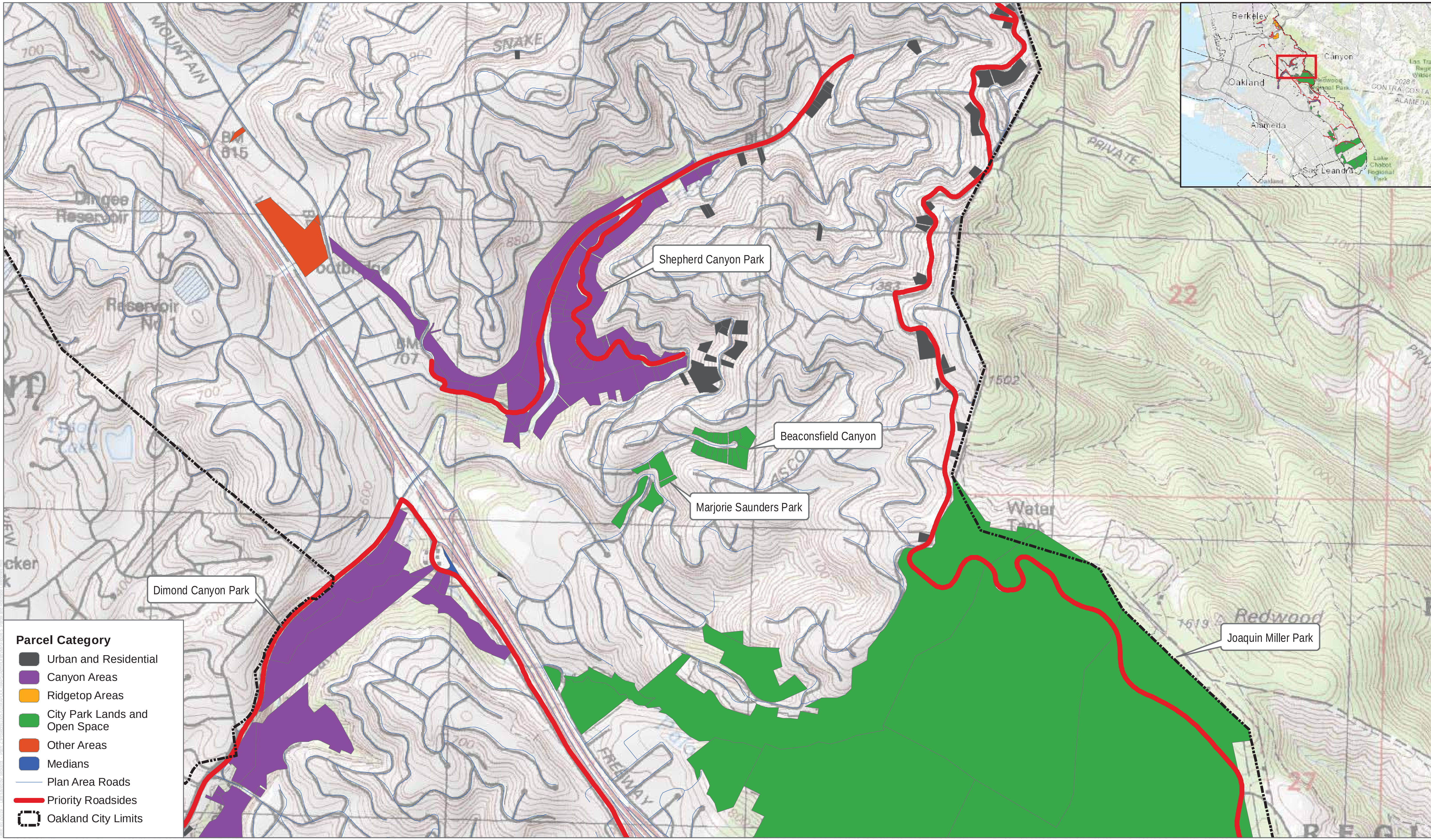

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 5.4

City-owned Parcel and Roadside Categories

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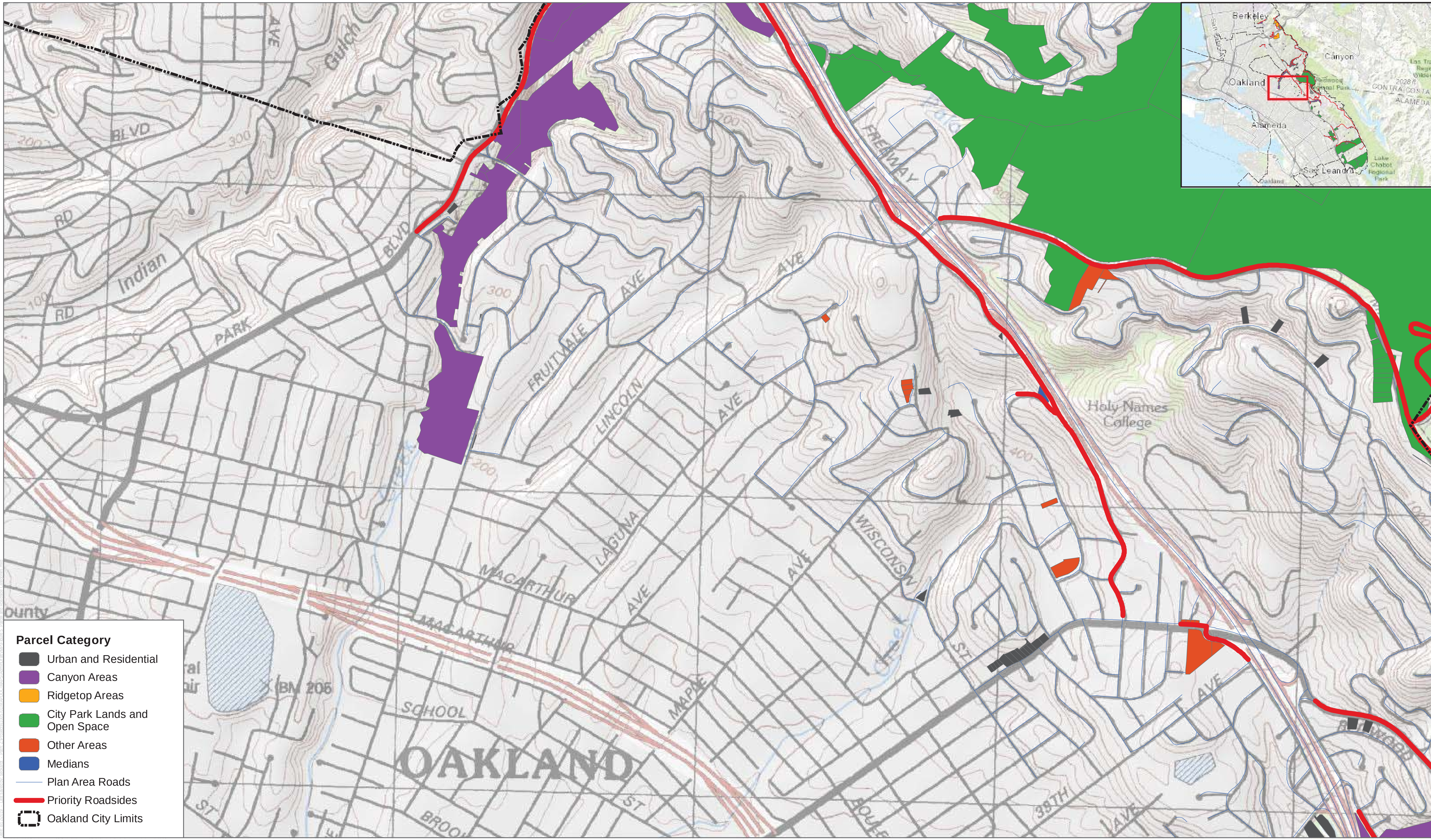

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 5.5

City-owned Parcel and Roadside Categories

Revised Draft Vegetation Management Plan - City of Oakland, California

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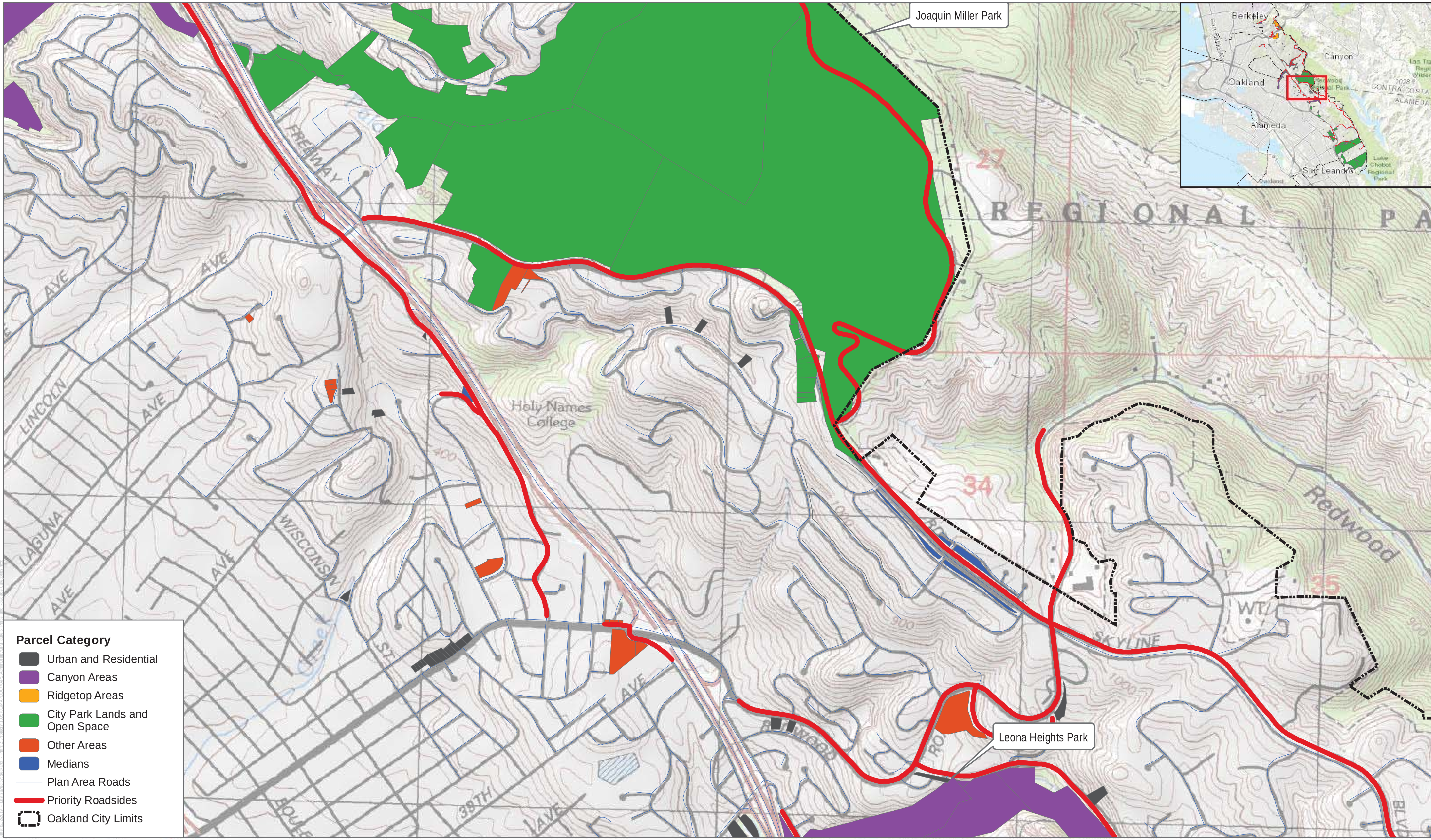

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 5.6

City-owned Parcel and Roadside Categories

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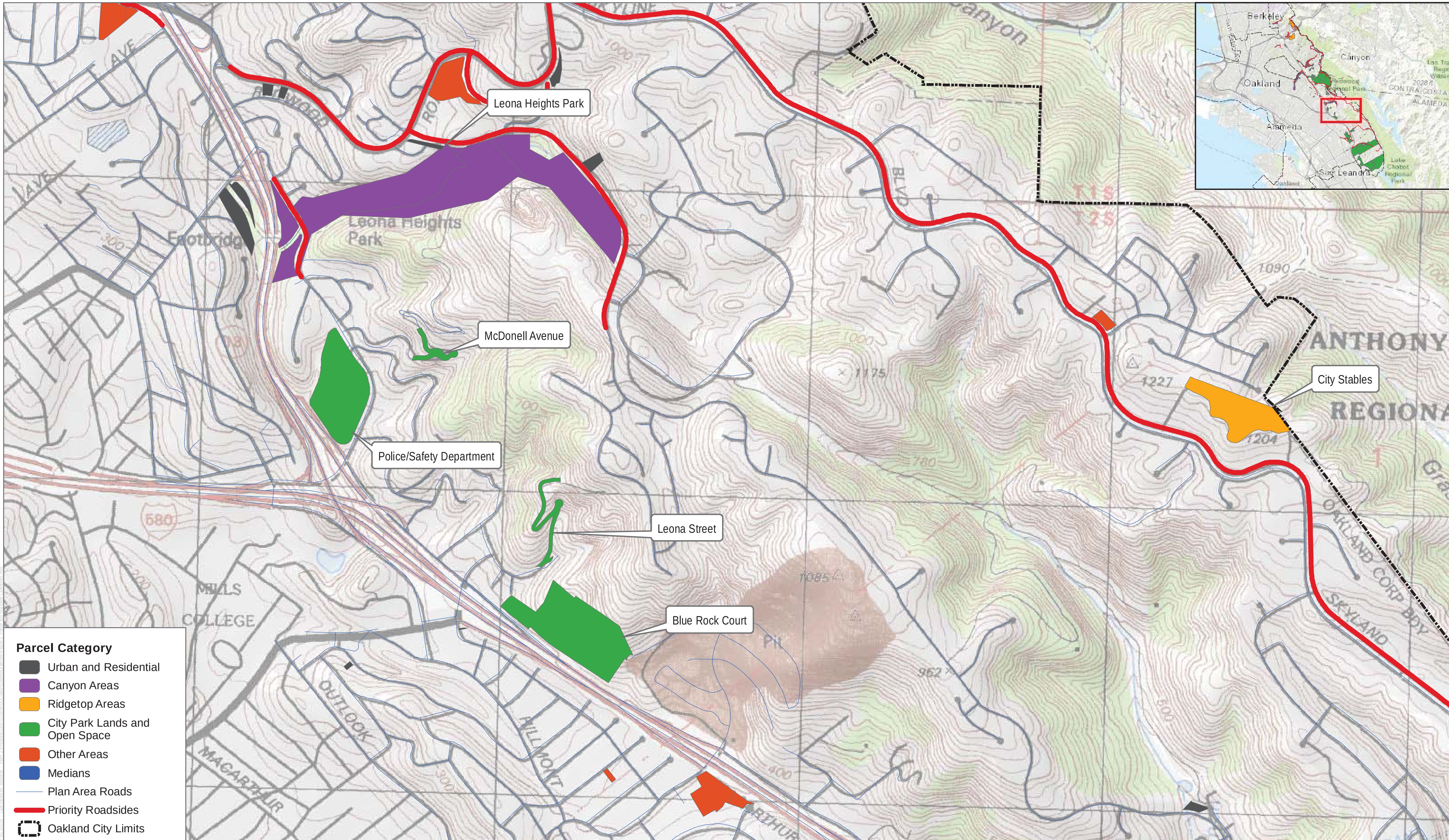

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 5.7

City-owned Parcel and Roadside Categories

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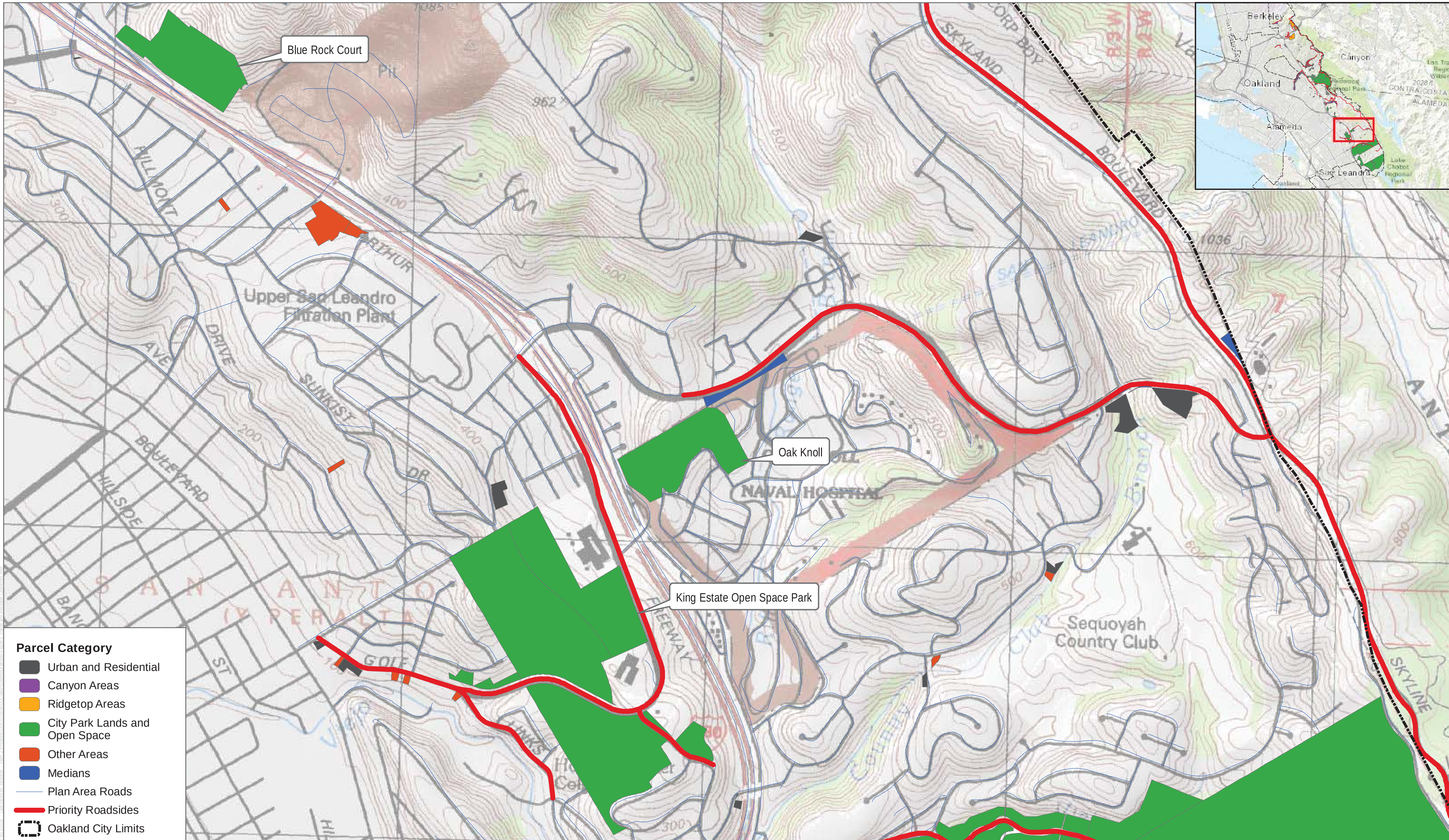

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 5.8

City-owned Parcel and Roadside Categories

Revised Draft Vegetation Management Plan - City of Oakland, California

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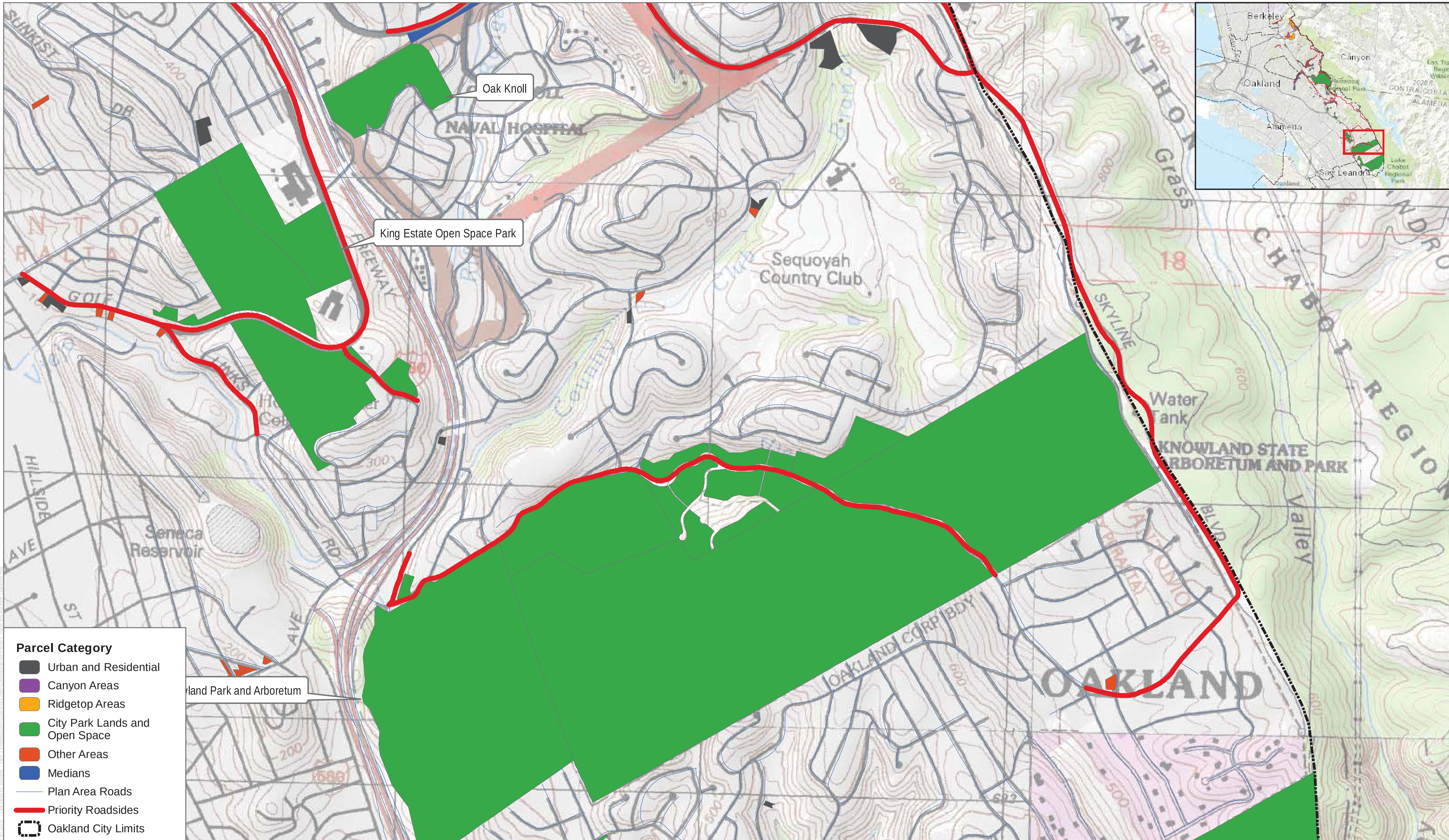

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 5.9

City-owned Parcel and Roadside Categories

Revised Draft Vegetation Management Plan - City of Oakland, California

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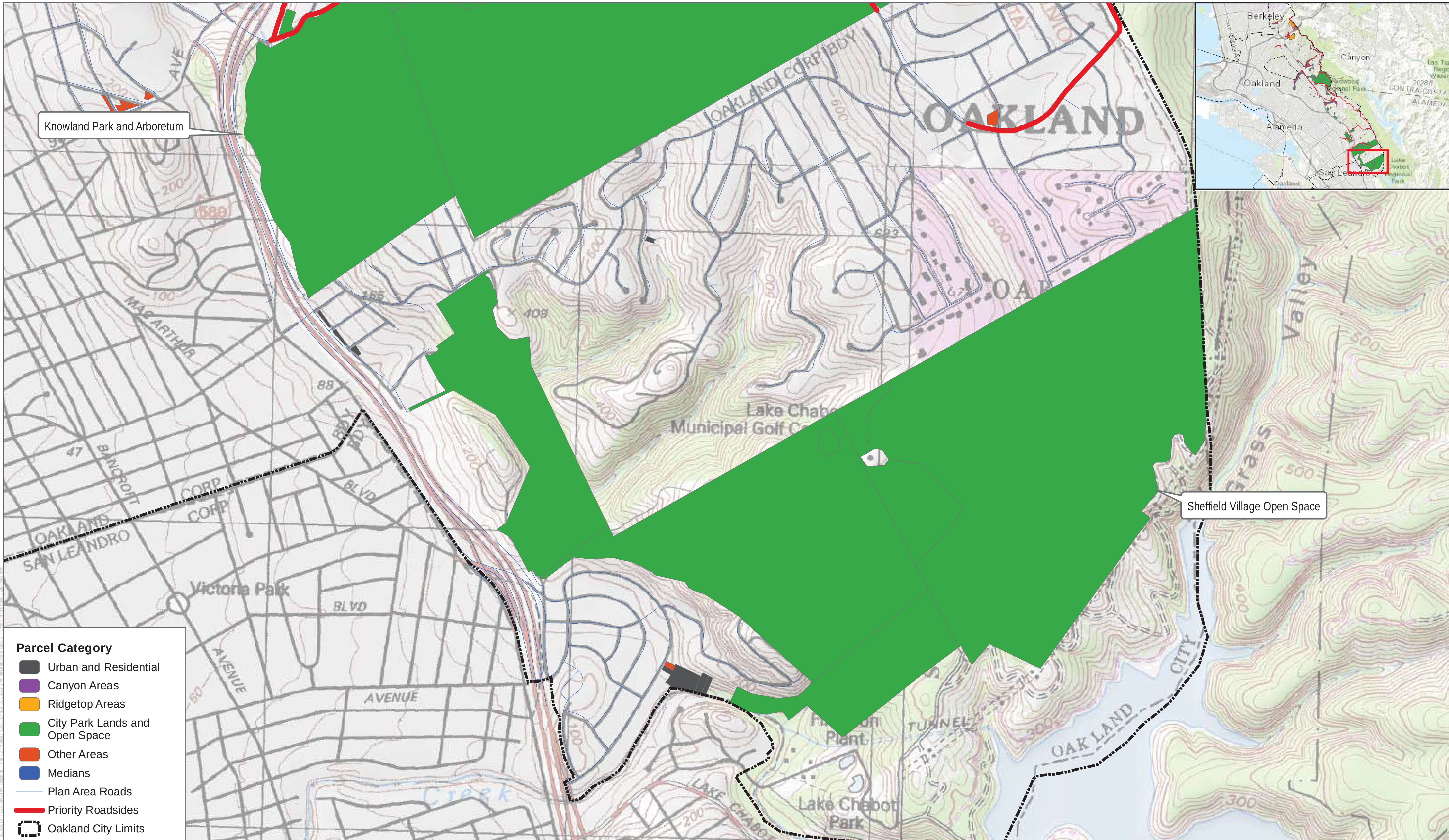

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 5.10

City-owned Parcel and Roadside Categories

Revised Draft Vegetation Management Plan - City of Oakland, California

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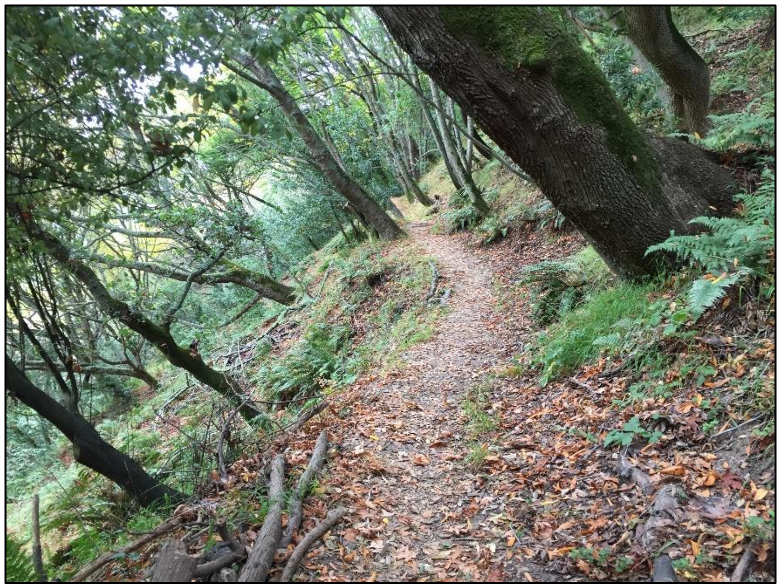
9.2.2 Canyon Areas

Canyon areas are collections of multiple adjacent parcels that are situated within and along canyons and drainages in the Plan Area. Four canyon areas have been identified in the Plan Area, and current and recommended vegetation management practices are presented for each in the following sections. The locations of canyon area parcels are presented in Figure 5.

9.2.2.1 Garber Park



Garber Park – oak woodland understory

Garber Park is collectively 14.3 acres in size and is situated primarily along the south side of Claremont Avenue at the bottom of Claremont Canyon. The park primarily consists of a north-facing slope and is mapped as the following vegetation communities/land cover types: coast oak woodland (13.4 acres), eucalyptus (0.7 acres), and freshwater emergent wetland (0.1 acre). Scatted eucalyptus, acacia, and pine trees are present within the mapped coast oak woodland. Garber Park Stewards and the Claremont Canyon Conservancy are active in vegetation management efforts in Garber Park.

Given its position within the lower part of the canyon and its north-facing slope, fuel moistures are typically high and fire hazard low. However, conditions in Garber Park may be very dry during the late summer and fall, depending on annual rainfall. The plant pathogen SOD is known to be present in Garber Park (UC Berkeley 2019), increasing the potential for dead oak trees to be present in this park. Downed tree branches and other woody debris located in gullies and on slopes in the park are a fire hazard. Fire behavior modeling resulted in no extreme fire behavior in Garber Park. Current management practices are limited to flashy fuel (e.g., grasses, weeds) treatment along Claremont Avenue to minimize ignition potential through the use of hand labor or mechanical techniques. A portion of the park falls within the 100-foot buffer from existing nearby residential structures, although treatment to 100 feet is not recommended due to the site's low fire hazard, except as noted below.

Park steward led maintenance projects have occurred in the following areas in Garber Park: the Fireplace plaza, Bob's Place (on both sides of Harwood Creek), the Claremont Avenue entrance and Fern Glade near this entrance, and maintenance of the trail system through hand labor. Local park stewards and OFD should coordinate with each other as needed, prior to any planned vegetation management activities so as to clarify management objectives, specific vegetation management activities, the timing of work activities, and other details. Please see Section 11.2 which describes the recommended communication and coordination protocol between OFD and local stewardship groups.

The following recommendations were developed in consultation with the Garber Park Stewards to manage vegetation and reduce the fire risk at Garber Park:

General vegetation management recommendations to reduce the fire risk in Garber Park include

- Maintain the existing trail networks to facilitate access and to create breaks in surface vegetation;
- Clear downed wood and other debris from gullies and remove dead limbs.

More specific recommendations to reduce the fire risk in Garber Park include the following projects:

- **GAR-1:** Manage vegetation along adjacent roadside (Claremont Avenue) and near trailheads/entry points to minimize ignition potential. Treatment width should be based on field observations, but not to exceed 30 feet. Specifically, trees hanging down on powerlines are a fire hazard and should be prioritized for treatment. At a 30-foot width, the treatment area equals 1.3 acres. **Priority 1**.
- **GAR-2:** Manage vegetation within 10 feet of the south and east property boundary line to facilitate firefighter access according to the standards outlined in Section 9.1. Treatment area equals 0.5 acres. **Priority 1**.
- **GAR-3:** To manage fuel loading rates, remove eucalyptus trees from two locations along the southern park boundary, retaining non-pyrophytic trees. Treatment area equals 0.7 acres. **Priority 3**.

9.2.2.2 Dimond Canyon Park

Dimond Canyon Park – riparian vegetation

Dimond Canyon Park is collectively 74.7 acres in size and is situated along Sausal Creek, south of State Route 13. The park includes the creek channel and some upland areas and is mapped as the following vegetation communities/land cover types: coast oak woodland (50.5 acres), coastal scrub (0.3 acres), eucalyptus (1.3 acres), redwood (5.5 acres), and urban (17.1 acres). It is primarily surrounded by residential development, with Park Boulevard forming its boundary in the northeast corner and Monterey Boulevard forming its boundary along the north. Leimert Boulevard and El Centro Avenue also bisect the park. Dimond Canyon Park includes both the undeveloped areas north of El Centro Avenue and the more developed Dimond Park.

The Friends of Dimond Park and the Friends of Sausal Creek stewardship groups are active in vegetation management efforts in Dimond Canyon Park. Friends of Sausal Creek have conducted several projects along Sausal Creek in Dimond Canyon. Local park stewards and OFD should coordinate with each other as needed, prior to any planned vegetation management activities so as to clarify management objectives, specific vegetation management activities, the timing of work activities, and other details. Please see Section 11.2 which describes the recommended communication and coordination protocol between OFD and local stewardship groups.

Given its position along Sausal Creek, fuel moistures along the lower portions of the park are typically high and fire hazard low. Drier and more hazardous conditions exist in the park's upland areas. Two fires have occurred within Dimond Canyon within the past three years. Dead stone pines present in the southern portion of Dimond Park represent a potential fire hazard. Fire behavior modeling resulted in primarily surface fire throughout the property, although small pockets of active crown fire were modeled in the coastal oak woodland area along Park Boulevard with grass/shrub understory and in a few small areas within the drainage with high slope gradients. Current management practices are limited to roadside treatment along Park Boulevard and Monterey Boulevard through the use of hand labor or mechanical techniques. Much of the park falls within the 100-foot buffer from existing structures, although treatment to 100 feet is not recommended due to lower fire hazard and the proximity to Sausal Creek.

The following recommendations were developed in consultation with the Friends of Sausal Creek and Friends of Dimond Park to manage vegetation and reduce the fire risk at Dimond Canyon Park. The following general management recommendations are provided for Dimond Canyon Park:

- Maintain the existing trail networks to facilitate access and to create breaks in surface vegetation. Trail maintenance should seek to provide unobstructed (horizontal and vertical) access for people traveling on foot
- Continue to monitor the park for dead or dying trees.

The following specific projects have been identified for Dimond Canyon Park:

- **DIM-1:** Manage vegetation along adjacent roadsides (Park Boulevard, Monterey Boulevard, Leimert Boulevard, El Centro Avenue) and near trailheads/entry points to minimize ignition potential. Treatment width should be based on field observations, but not to exceed 30 feet. At a 30-foot width, the treatment area equals 3.4 acres. **Priority 1**.
- **DIM-2:** Manage vegetation within 10 feet of property boundary lines where the park abuts residential structures to facilitate firefighter access according to the standards outlined in Section 9.1. Treatment area equals 2.5 acres. **Priority 1**.
- **DIM-3:** Manage vegetation in the area between the parking lot located to the east of the pool and the adjacent residential structures (approximately 50 feet in width). Treatment area equals 0.7 acres. **Priority 1**.

9.2.2.3 Shepherd Canyon Park


Shepherd Canyon Park – grass with tree overstory

Shepherd Canyon Park is collectively 57.9 acres in size and is situated along Shepherd Creek in Shepherd Canyon, northeast of State Route 13. The park includes the creek channel and some upland areas and is mapped as the following vegetation communities/land cover types: annual grassland (2.0 acres), closed-cone pine-cypress (1.5 acres), coastal oak woodland (31.9 acres), eucalyptus (16.6 acres), and urban (5.9 acres). For the purposes of this VMP, this park also includes the Montclair Railroad Trail property that runs west from Snake Road to Mountain Boulevard. Significant amounts of broom exist in the park, primarily along Shepherd Canyon Road. It is primarily surrounded by residential development and is bounded primarily on the west by Shepherd Canyon Road.

The Friends of Sausal Creek, Shepherd Canyon Homeowners, and the Friends of Montclair Railroad Trail are active in vegetation management efforts in Shepherd Canyon Park. Friends of the Montclair Railroad Trail have conducted several revegetation projects along the railroad trail, such as beneath the PG&E power lines and at Cortereal Avenue. Local park stewards and OFD should coordinate with each other, as needed, prior to any planned vegetation management activities so as to clarify management objectives, specific vegetation management activities, the timing of work activities, and other details. Please see Section 12.2 which describes the recommended communication and coordination protocol between OFD and local stewardship groups.

Given its position along Shepherd Creek, fuel moistures along the lower portions of the park are typically high and fire hazard low; however, drier and more hazardous conditions exist in the park's upland areas. Fire behavior modeling resulted in active and passive crown fire concentrated along the western side of Shepherd Canyon Road where broom exists beneath eucalyptus tree canopies and surface fire throughout the remainder of the property. Dead are dying trees in the park (e.g. near Bishops Court and near the Escher fire road) represent a potential fire hazard. Homeless encampments also pose an ignition risk. Current management practices include roadside treatment along Shepherd Canyon Road through the use of hand labor or mechanical techniques, and hand labor treatment, mechanical treatment, or grazing throughout the park to reduce ladder fuels, control invasive species, and reduce and maintain surface fuel loads. Approximately 9 acres of the park are currently grazed annually. Much of the park falls within the 100-foot buffer from existing structures or within 30 feet of existing roads.

The following recommendations were developed in consultation with the Friends of Sausal Creek, the Shepherd Canyon Homeowners, and the Friends of Montclair Railroad Trail to manage vegetation and reduce the fire risk at Shepherd Canyon Park. The following general management recommendations are provided for Shepherd Canyon Park:

- Maintain the existing trail networks to facilitate access and to create breaks in surface vegetation. Existing fire roads (ex. the Escher fire road) should be treated to maintain access;
- Manage vegetation consistent with the schedule for clearance of private parcels in the same geographic area, if feasible.

The following specific projects have been identified for Shepherd Canyon Park:

- **SHP-1:** Manage vegetation within 100 feet of structures and within 150 feet of the park access gate according to the standards outlined in Section 9.1. Treatment area equals 13.2 acres. **Priority 1**.
- **SHP-2:** Manage vegetation along adjacent roadsides (Shepherd Canyon Road, Escher Drive, Snake Road, and Bagshotte Drive) to minimize ignition potential. Treatment width should be based on field observations, but not to exceed 30 feet. At a 30-foot width, the treatment area equals 9.3 acres. **Priority 1**.
- **SHP-3:** Implement brush and tree thinning recommendations in areas exhibiting extreme fire behavior and within 300 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 11.8 acres. **Priority 2**.
- **SHP-4:** Continue to manage vegetation via grazing throughout the remainder of the park to maintain fuel loads. Grazing should be conducted later in the season after perennial grasses go to seed. Treatment area equals 20.4 acres. **Priority 3**.

9.2.2.4 Leona Heights Park

Leona Heights Park – upland area vegetation

Leona Heights Park is collectively 42.3 acres in size and is situated along a drainage south of Redwood Road and Campus Drive and east of State Route 13. The park includes the drainage channel and some upland areas and also extends south of the Merritt College parking lot located west of Campus Drive. Leona Heights Park is mapped as the following vegetation communities/land cover types: annual grassland (0.3 acres), coastal oak woodland (25.7 acres), eucalyptus (2.1 acres), redwood (13.8 acres), and urban (0.5 acres). The park is largely inaccessible given its steep terrain, with the exception of some trails. The Friends of Leona Heights Park stewardship group has historically been active in vegetation management efforts in Leona Heights Park. Local park stewards and OFD should coordinate with each other as needed, prior to any planned vegetation management activities so as to clarify management objectives, specific vegetation management activities, the timing of work activities, and other details. Please see Section 11.2 which describes the recommended communication and coordination protocol between OFD and local stewardship groups.

Fire behavior modeling resulted in active and passive crown fire in coastal oak woodlands in upland areas in the eastern and northern portions of the park and primarily surface fire within redwood stands along the drainage bottom. Some isolated active crown fire was modeled in areas with steep slope gradients and only surface fire was modeled in the managed eucalyptus and oak stands at the park's western edge. Current management practices are limited to roadside treatment along Campus Drive through the use of hand labor or mechanical techniques, and hand labor treatment, mechanical treatment, or grazing in the lower portion of the park (approximately 9 acres) to reduce ladder fuels, control invasive species, and reduce and maintain surface fuel loads. A portion of the park falls within the 100-foot buffer from existing structures, along its northern and western boundaries.

The following specific projects have been identified for Leona Heights Park:

- **LHT-1:** Manage vegetation within 100 feet of structures, within 300 feet of ridgelines, and within the current 9-acre management area according to the standards outlined in Section 9.1. Treatment area equals 13.6 acres. **Priority 1**.
- **LHT-2:** Manage vegetation along adjacent roadside (Campus Drive) to minimize ignition potential. Treatment width should be based on field observations, but not to exceed 30 feet. At a 30-foot width, the treatment area equals 1.9 acres. **Priority 1**.
- **LHT-3:** Implement brush and tree thinning recommendations in areas exhibiting extreme fire behavior and within 300 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 3.8 acres. **Priority 2**.

9.2.2.5 Beaconsfield Canyon

Beaconsfield Canyon is collectively 4.3 acres and is located at the end of Chelton Drive, southeast of Shepherd Canyon Park. Beaconsfield Canyon is mapped as the following vegetation communities/land cover types: closed-cone pine-cypress (1.4 acres), coastal oak woodland (1.4 acres), and coastal scrub (1.5 acres). Active and passive crown fire in coastal scrub where overstory trees are present. Surface fire only throughout the remainder of the property. The Friends of Sausal Creek stewardship group is active in vegetation management efforts on the Beaconsfield Canyon property. Local park stewards and OFD should coordinate with each other as needed, prior to any planned vegetation management activities so as to clarify management objectives, specific vegetation management activities, the timing of work activities, and other details. Please see Section 11.2 which describes the recommended communication and coordination protocol between OFD and local stewardship groups. The following recommendations were developed in consultation with the Friends of Sausal Creek to manage vegetation and reduce the fire risk at Beaconsfield Canyon. The following specific projects have been identified for the Beaconsfield Canyon property:

- **BCN-1:** Manage vegetation within 100 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 1.7 acres. **Priority 1**.
- **BCN-2:** Implement brush and tree thinning recommendations in areas exhibiting extreme fire behavior and within 300 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 2.0 acres. **Priority 2**

9.2.3 Ridgetop Areas

Ridgetop areas are single parcels or collections of multiple adjacent parcels that are situated at or near the summit of the Oakland Hills in the Plan Area. Ridgetop areas present high fire hazard conditions due to typically lower fuel moistures and the potential for high or erratic winds during wildfire events. Three ridgetop areas have been identified in the Plan Area and current and recommended vegetation management practices are presented for each in the following sections. Establishing fuel breaks at ridgelines is common practice and they help moderate fire behavior and serve as important fire suppression control points. As described in Section 2.2, ridgelines experience more and erratic winds, and fires gain speed and intensity and can behave erratically when burning near a ridgeline. The locations of ridgetop area parcels are presented in Figure 5.

9.2.3.1 North Oakland Regional Sports Field

The North Oakland Regional Sports Field property is collectively 53.6 acres in size and is situated to the south of State Route 24 immediately south of the Caldecott tunnels. The North Oakland Regional Sports Field property is mapped as the following vegetation communities/land cover types: coastal oak woodland (22.0 acres), coastal scrub (2.1 acres), eucalyptus (19.8 acres), urban (9.1 acres), and valley-foothill riparian (0.6 acres). The Oakland Landscape Committee is active in vegetation management efforts on the North Oakland Regional Sports Field property.

North Oakland Regional Sports Field – eucalyptus stand

The property is characterized by a second-growth eucalyptus stand in its northern and eastern portions, which were burned in the 1991 Tunnel Fire, and a coastal oak woodland stand in its southern half. The eucalyptus stands have a substantial understory of French broom and other highly flammable species. The lower, central portion of the property includes a tributary stream to Temescal Creek, ball fields, and a dirt access road bisects the property as it runs upward from Broadway in the west, through the eucalyptus stand, toward the houses above on Skyline Boulevard. Flammable species such as pampas/jubata grass and French broom also occur along Broadway. Public use in the lower and upper portions of the property is a potential ignition source. Fire behavior modeling resulted in active crown fire throughout most of the property's tree-dominated vegetation (eucalyptus and coastal oak woodland) and surface fire concentrated in managed areas along the property's dirt access road and in the area between the sports field and the eucalyptus stand.

Eucalyptus longhorn borer beetles have been documented in eucalyptus stands in the property. This species can cause eucalyptus stress and mortality, and leads to increased fire risk. Although it has not been constructed, a trail may be constructed adjacent to the service road from the parking lot area to the beginning of the fire trail. This trail could increase the number of park users frequenting the northern portion of the property. Homeless encampments also pose an ignition risk.

Current management practices are limited to roadside treatment along the property's dirt access road through the use of hand labor or mechanical techniques to reduce ladder fuels, control invasive species, and reduce and maintain surface fuel loads. Goat grazing also occurred at this property in 2018 and 2019. The property is beyond 300 feet from existing residential structures, although the property includes a bathroom structure, snack bar/eating area, and wooden bleacher seats. Fire behavior modeling reveals a potential for extreme fire behavior, as noted. Local park stewards and OFD should coordinate with each other as needed, prior to any planned vegetation management activities so as to clarify management objectives, specific vegetation management activities, the timing of work activities, and other details. Please see Section 11.2 which describes the recommended communication and coordination protocol between OFD and local stewardship groups.

The following recommendations were developed in consultation with the Oakland Landscape Committee to manage vegetation and reduce the fire risk at the North Oakland Regional Sports Field property. The following general management recommendations are provided for the North Oakland Regional Sports Field property:

- Maintain the site's dirt access road in a serviceable condition, improving roadside drainage where erosion and gullying have deteriorated access road.
- Implement measures to prevent unauthorized vehicle access to the property's dirt access road.
- Continue to manage vegetation via grazing to maintain fuel loads and minimize ignition potential.

The following specific projects have been identified for the North Oakland Regional Sports Field property:

- **NOR-1:** Manage vegetation according to the standards outlined in Section 9.1 in the following locations: within 30 feet of the site's dirt access road, within 300 feet of ridgelines, within 150 feet of the park access gate, and within the existing managed area north of the ball fields and parking areas. Treatment area equals 21.5 acres. **Priority 1**.

- **NOR-2:** Given the upper portion of the property's ridgetop location and the potential for ember generation resulting from crown fire, implement thinning recommendations in the property's eucalyptus stand beyond that treated under project NOR-1 according to the standards outlined in Section 9.1. Treatment area equals 7.8 acres. **Priority 2**.
- **NOR-3:** To reduce fuel loading rates, remove eucalyptus trees and other highly flammable and invasive plants from oak woodland communities, retaining non-pyrophytic trees. Treatment area equals 18.6 acres. **Priority 3**.

North Oakland Regional Sports Field – previously thinned area downslope of non-thinned eucalyptus stand

A phased mosaic approach to Projects NOR-1 and NOR-2 may be appropriate, where 3-5 acres are thinned at a time, and follow-up maintenance occurs. This would limit the impacts to potential soil erosion, biological resources, and also moderate the overall cost over a longer planning period. This approach has been implemented on an approximate 5-acre section of the lower south facing hillslope.

9.2.3.2 Grizzly Peak Open Space

The Grizzly Peak Open Space property is collectively 64.5 acres in size and is situated along the southwest side of Grizzly Peak Boulevard, southeast of Marlborough Terrace. The property generally extends between Grizzly Peak Boulevard at the top of the slope down to Bay Forest Drive, Tunnel Road, Buckingham Boulevard, and Westmoreland Drive at the slope bottom. The Grizzly Peak Open Space property is mapped as the following vegetation communities/land cover types: closed-cone pine-cypress (25.7 acres), coastal oak woodland (3.2 acres), coastal scrub (33.3 acres), eucalyptus (0.6 acres), and urban (1.6 acres). No stewardship groups are currently active in vegetation management efforts on the Grizzly Peak Open Space property. Local park stewards and OFD should coordinate with each other as needed, prior to any planned vegetation management activities so as to clarify management objectives, specific vegetation management activities, the timing of work activities, and other details. Please see Section 11.2 which describes the recommended communication and coordination protocol between OFD and local stewardship groups.

The property extends across a steep, southwest-facing slope and abuts residential structures, community assets (communications facility), and a priority access/egress route (Grizzly Peak Boulevard). Views from the property increase human presence along Grizzly Peak Boulevard, increasing potential ignition sources. Fire behavior modeling resulted in torching of tree canopies along the upper, northeastern portion of the property and active crown fire along the lower, southwestern portion of property in pine and eucalyptus stands.


Grizzly Peak Open Space – upper portion along Grizzly Peak Boulevard

Current management practices include roadside treatment along Grizzly Peak Boulevard through the use of hand labor or mechanical techniques, hand labor or mechanical treatment along Bay Forest Drive in the lower portions of the property, and grazing throughout the property to reduce ladder fuels, control invasive species, and reduce and maintain surface fuel loads. Fire behavior modeling reveals a potential for extreme fire behavior, as noted. The upper and lower portions of the property fall within the 100-foot buffer from existing structures and much of the property falls within 300 feet of structures.

The following specific projects have been identified for the Grizzly Peak Open Space property:

- **GPO-1:** Manage vegetation within 100 feet of structures, within 300 feet of ridgelines, and within 30 feet of Tunnel Road and Bay Forest Drive according to the standards outlined in Section 9.1. Treatment area equals 28.5 acres. **Priority 1.**
- **GPO-2:** Implement brush and tree thinning recommendations in areas exhibiting extreme fire behavior and within 300 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 19.1 acres. **Priority 2**.
- **GPO-3:** To reduce fuel loading rates, remove eucalyptus trees and other highly flammable and invasive plants from oak woodlands, retaining non-pyrophytic trees. Treatment area equals 1.6 acres. **Priority 3.**
- **GPO-4:** Continue to manage vegetation via grazing throughout the remainder of the property to maintain fuel loads. Treatment area equals 19.9 acres. **Priority 3.**

9.2.3.3 City Stables

The City stables property is 7.4 acres, is located along Skyline Boulevard, is dominated by grassland fuels, and is largely within 10 feet from existing structures. One of the City's remote automated weather stations is situated in the property. No volunteer stewardship groups are active at the City Stables property Fire behavior modeling resulted in no extreme fire behavior on the City Stables property. Vegetation management on this parcel is focused on reducing surface fuels (e.g., grasses, weeds) and maintaining fuel loads through the use of hand labor, mechanical techniques, or grazing. The property is currently leased to a private contractor who retains responsibility for vegetation management. If the current lease expires within the timeframe of this VMP and the City regains management responsibility, it is recommended to resume management of vegetation on the entire property according to the standards outlined in Section 9.1. Currently, no specific projects have been identified for the City Stables property.

9.2.4 City Park Lands and Open Space

City park lands and open space areas are collections of multiple adjacent parcels, are characterized by numerous vegetation types, and typically present high fire hazard conditions due to terrain, vegetation, and increased human presence resulting in increased ignition potential. Four primary park land and open space areas have been identified in the Plan Area; current and recommended vegetation management practices are presented for each in the following sections. In addition, smaller properties or collections of parcels that exhibit similar vegetation conditions have been included in this designation and are also summarized below. The locations of park land and open space parcels are presented in Figure 5.

9.2.4.1 Sheffield Village Open Space

Sheffield Village Open Space is collectively 455.4 acres in size and is situated at the southeastern-most portion of the Plan Area, at the southern end of Golf Links Road and at the northwestern end of Lake Chabot. The property includes the Lake Chabot Golf Course; however, given the low fire hazard condition of the golf course, no management recommendations are provided for that portion of the property. The Sheffield Village Open Space area also includes the historic Dunsmuir Estate. Sheffield Village Open Space is mapped as the following vegetation communities/land cover types: annual grassland (59.4 acres), closed-cone pine-cypress (5.9 acres), coastal oak woodland (143.9 acres), coastal scrub (59.3 acres), eucalyptus (27.9 acres), perennial grassland (0.8 acres), and urban (158.1 acres). No stewardship groups are currently active in vegetation management efforts on the Sheffield Village Open Space property. Local park stewards and OFD should coordinate with each other as needed, prior to any planned vegetation management activities so as to clarify management objectives, specific vegetation management activities, the timing of work activities, and other details. Please see Section 11.2 which describes the recommended communication and coordination protocol between OFD and local stewardship groups.

Fire behavior modeling resulted in active crown fire in coastal scrub (where overstory trees are present), oak stands with a heavy shrub understory, and isolated areas within oak woodlands with grass understory where slope gradients are high and surface fire only throughout the remainder of the property.

Current management practices include grazing throughout the property (excluding the golf course and developed/landscaped portions of the Dunsmuir Estate) to reduce ladder fuels, control invasive species, and reduce and maintain surface fuel loads. Portions of the southern edge of the property fall within the 100-foot and 300-foot buffers from existing structures. On-site structures include those in the Dunsmuir Estate portion of the property (at the end of Peralta Oaks Court).

Sheffield Village Open Space – grazed grassland and oak woodlands

The following general management recommendations are provided for the Sheffield Village Open Space property:

- Maintain the existing trail/road networks to facilitate access and to create breaks in surface vegetation.

The following specific projects have been identified for the Sheffield Village Open Space property:

- **SHF-1:** Manage vegetation within 100 feet of structures, including those in the Dunsmuir Estates portion of the property, and within 150 feet of park access gates, according to the standards outlined in Section 9.1. Treatment area equals 23.9 acres. **Priority 1**.
- **SHF-2:** Manage vegetation within 300 feet of structures in areas that exhibit extreme fire behavior according to the standards outlined in Section 9.1. Treatment area equals 6.1 acres. **Priority 2**.
- **SHF-3:** Continue to manage vegetation via grazing throughout the remainder of the park to maintain fuel loads. Treatment area equals 288.3 acres. **Priority 3**.

9.2.4.2 Knowland Park and Arboretum

Knowland Park and Arboretum is collectively 473.5 acres in size and is situated in the southeastern portion of the Plan Area. The property extends between Interstate 580 in the southwest and Skyline Boulevard in the northeast and is bisected by Golf Links Road. The property includes the Oakland Zoo at the southwestern edge and a newly constructed gondola between the zoo and a hilltop near the center of the property, where an additional fenced zoo exhibit is now located. The Knowland Park and Arboretum property is mapped as the following vegetation communities/land cover types: annual grassland (102.9 acres), mixed chaparral (also known as maritime chaparral) (8.1 acres), closed-cone pine-cypress (9.1 acres), coastal oak woodland (162.0 acres), coastal scrub (61.8 acres), eucalyptus (12.1 acres), freshwater emergent wetland (0.2 acres), perennial grassland (12.5 acres), redwood (0.2 acres), and urban (104.9 acres). The Friends of Knowland Park stewardship group is active in vegetation management efforts on the Knowland Park and Arboretum property. Local park stewards and OFD should coordinate with each other as needed, prior to any planned vegetation management activities so as to clarify management objectives, specific vegetation management activities, the timing of work activities, and other details. Please see Section 11.2 which describes the recommended communication and coordination protocol between OFD and local stewardship groups.

Views from the water tank situated along Skyline Boulevard at the property's northeastern boundary increase human presence thereby increasing potential ignition sources. The Oakland Zoo's "California Trail" operations, including overnight campgrounds, may increase the potential for ignition in Knowland Park. For example, the California Trail electrified fence was observed to be sparking over the 2018 winter, which could be an ignition risk during the dry season. Unauthorized motorized vehicle use (including two wheeled motorized vehicle use) within the park pose and additional ignition risk. Fire behavior modeling resulted in active crown fire in the coastal scrub and chaparral stands in the central and eastern portions of the property (where overstory trees are present) and in the eucalyptus stands in the western portion of the property and surface fire only throughout the remainder of the property.

Knowland Park and Arboretum – grazed grassland and scattered trees

Current management practices include roadside treatment along Golf Links Road through the center of the property through the use of hand labor or mechanical techniques and grazing throughout the property to reduce ladder fuels, control invasive species, and reduce and maintain surface fuel loads. Approximately 350 acres of the property are currently grazed annually. Grazing is currently rotated every two years in a checkerboard approach so all areas are covered. The Friends of Knowland Park have worked with the City's grazing contractor to help minimize impacts on vegetation and plants that are rare within the park. In general, this has been accomplished by on-site, active management of the goat herd by the contractor, as well as by establishing exclusion areas. Much of the perimeter of the property falls within the 100-foot and 300-foot buffers from existing structures.

The following recommendations were developed in consultation with the Friends of Knowland Park to manage vegetation and reduce the fire risk at the Knowland Park and Arboretum property. The following general management recommendations are provided for the Knowland Park and Arboretum property:

- Maintain the existing trail/road networks to facilitate access and to create breaks in surface vegetation.
- Implement measures to prevent unauthorized vehicle access (including two-wheel motorized vehicles) to the property's dirt access roads.
- Install signage at park entrances indicating that Knowland Park and Arboretum is a City of Oakland park, and notifying visitors of Park rules, including that campfires, fireworks, and other fire hazardous activities are prohibited.
- Grass heights following grazing treatment should be targeted to between 4-6 inches in height.
- Goats should be excluded from sensitive areas, such as rock outcrops and the emergent wetland.

- Where feasible, shrubs such as coffeeberry (*Frangula californica*), toyon (*Heteromeles arbutifolia*), and gooseberry (*Ribes* spp) should be protected from goat grazing

The following specific projects have been identified for the Knowland Park and Arboretum property:

- **KNO-1:** Manage vegetation within 100 feet of structures, within 150 feet of park access gates, and within 300 feet of ridgelines, which encompasses the area within 30 feet of known human congregation/activity areas along Skyline Boulevard according to the standards outlined in Section 9.1. Treatment area equals 28.4 acres. **Priority 1**.
- **KNO-2:** Manage vegetation along adjacent roadside (Golf Links Road). Treatment width should be based on field observations, but not to exceed 30 feet. At a 30-foot width, the treatment area equals 8.4 acres. **Priority 1.**
- **KNO-3:** Manage vegetation within 300 feet of structures in areas that exhibit extreme fire behavior according to the standards outlined in Section 9.1. Treatment area equals 14.0 acres. **Priority 2**.
- **KNO-4:** Manage vegetation within 100 feet of on-site structures in the zoo portion of the property and within 100 feet of the zoo/open space interface to minimize ignition potential and modify potential fire behavior near this developed portion of the property. Treatment area equals 32.1 acres. **Priority 2**.
- **KNO-5:** Continue to manage vegetation via grazing throughout the remainder of the park to maintain fuel loads. Treatment area equals 368.1 acres. **Priority 3**.

9.2.4.3 Joaquin Miller Park

Joaquin Miller Park – trail through acacia tree stand

Joaquin Miller Park is 454.9 acres in size and is situated in the southeastern portion of the Plan Area. The property extends between Joaquin Miller Road in the south, Skyline Boulevard in the east, Castle Drive in the west, and the Oakland Hills ridgeline in the north. Skyline Boulevard runs along the park's western edge then through the northern portion of the park where it exits at the park's northern corner. The southern portion of the park is more developed and includes access roads, parking areas, the Woodminster Amphitheater, a dog park, a nursery, and several structures (including the Community Center, Ranger Station, the historic Joaquin Miller house, Sequoia Lodge, Sequoia Arena, and the Metropolitan Horseman's Association Clubhouse). The northern portion of the park is less developed, but provides for public access along numerous trails and dirt roads. Many of the fire roads within the park have not been maintained and are no longer accessible to vehicles due to vegetation growth. The CSSC and the associated pallid manzanita restoration site is located partially on and off site but adjacent to the park's northern property boundary. Other populations of pallid manzanita are present in the park, as well as populations of other rare plants. Several canyons are present in the park, including Palo Seco and Cinderella Canyons and Fern Ravine.

Joaquin Miller Park is mapped as the following vegetation communities/land cover types: annual grassland (15.0 acres), closed-cone pine-cypress (109.3 acres), coastal oak woodland (88.0 acres), coastal scrub (5.8 acres), eucalyptus (62.0 acres), redwood (121.0 acres), urban (42.8 acres), urban (acacia) (6.6 acres), urban (mixed tree stand) (3.7 acres), and valley/foothill riparian (0.8 acres). In recent years, Monterey pine trees in the park have been reaching the end of their lifespan and dying, contributing to fuel load in the park.

The Friends of Sausal Creek and the Friends of Joaquin Miller Park stewardship groups are active in vegetation management efforts in Joaquin Miller Park. The Friends of Sausal Creek have worked with the City's grazing contractor to help minimize impacts on plants that are rare within the park. In general, this has been accomplished by establishing exclusion areas. Some areas are grazed only when needed to limit specific invasive plants. Generally, the Friends of Sausal Creek provide maps, stake and flag individual plants and patches, and consult with the grazing contractor on site as needed. Local park stewards and OFD should coordinate with each other as needed, prior to any planned vegetation management activities so as to clarify management objectives, specific vegetation management activities, the timing of work activities, and other details. Please see Section 11.2 which describes the recommended communication and coordination protocol between OFD and local stewardship groups.

Known areas for potential ignitions include a congregation area/car dump site along Skyline Boulevard approximately 800 feet up from its intersection with Joaquin Miller Drive, a congregation area at the intersection of Castle Drive and Skyline Boulevard, and a congregation/bonfire area located at the top of Woodside Glen Court. Fire behavior modeling resulted in active and passive crown fire within the northern and central portions of the park within non-managed oak, pine, eucalyptus, and acacia stands. Active and passive crown fire also modeled within the acacia and mixed tree stands within the southern (lower) portions of the park and only surface fire modeled within redwood stands and throughout the lower, developed and managed portions of the park (except acacia and mixed tree stands). Trees located along Joaquin Miller Road and Skyline Boulevard could pose obstacles to egress if they fall across these roads during a fire.

Current management practices include roadside treatment along Joaquin Miller Road along the entire southern edge of the park and along Skyline Boulevard through the park through the use of hand labor or mechanical techniques. Vegetation is also managed by hand labor or mechanical techniques in the areas adjacent to the dirt parking lot to the west of the CSSC, at the WUI along the park's northwestern boundary, and around structures, the dog park, and the amphitheater in the developed portion of the park. Fire trails within the center of the park are cleared, and vegetation within 20 feet of the trails managed via hand labor. Volunteers, in collaboration with the Oakland Department of Public Works, have typically conducted the majority of trail maintenance work in the park. Grazing is also conducted throughout the park in light, flashy fuel areas (grasslands, disturbed areas) to reduce and maintain surface fuel loads. Approximately 150 acres of the property are currently grazed annually. Fire behavior modeling reveals a potential for extreme fire behavior in the property's pine, eucalyptus, acacia, and mixed tree stands. Much of the southern and western portions of the park's perimeter fall within the 100-foot and 300-foot buffers from existing structures.

The following recommendations were developed in consultation with the Friends of Sausal Creek and the Friends of Joaquin Miller Park to manage vegetation and reduce the fire risk at Joaquin Miller Park. The following general management recommendations are provided for the Joaquin Miller Park:

- Maintain the existing fire trail/dirt road network to facilitate access and to create breaks in surface vegetation.
- Avoid treatment within the pallid manzanita restoration area adjacent to the CSSC and on both sides of Skyline Boulevard near the Redwood Glen Trailhead, approximately 500 feet west of the Roberts Park main entrance (this is known as the 'Big Trees' pallid manzanita population). Also avoid treatment activities in pallid manzanita planting areas adjacent to the nursery.
- Avoid treatment on serpentine roadcuts, in particular the serpentine slopes at the intersection of Joaquin Miller Road and Skyline Boulevard. Rare plants including Tiburon buckwheat are known to occur in this location. Rare plant locations along these serpentine slopes extend along Joaquin Miller road approximately 300 feet northwest from the intersection and along Skyline Boulevard approximately 400 feet from the intersection.
- Removal of acacia and pine seedlings saplings can be targeted in treatment areas.
- Avoid treatment in identified memorial tree planting sites.
- Avoid treatment within the emergent wetland located in the northern portion of Joaquin Miller Park.
- Implement measures to prevent unauthorized vehicle access to the park's dirt access roads.

The following specific projects have been identified for Joaquin Miller Park:

- **JMP-1:** Manage vegetation within 100 feet of on and off-site structures, within 300 feet of ridgelines, within 150 feet of park access gates and within 30 feet of known human congregation/activity areas along Skyline Boulevard and the top of Woodside Glen Court according to the standards outlined in Section 9.1. Treatment area equals 117.3 acres. **Priority 1**.
- **JMP-2:** Manage vegetation along adjacent roadsides (Joaquin Miller Road, Skyline Boulevard, and Mountain Boulevard). Treatment width should be based on field observations, but not to exceed 30 feet. At a 30-foot width, the treatment area equals 18.2 acres. **Priority 1**.
- **JMP-3:** Implement brush and tree thinning recommendations in areas exhibiting extreme fire behavior and within 300 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 13.8 acres. **Priority 2**.
- **JMP-4:** Continue to manage vegetation via grazing in flashy fuel areas to maintain fuel loads. Treatment area equals 68.3 acres. **Priority 3.**

9.2.4.4 King Estate Open Space Park

The King Estate Open Space Park is collectively 81.3 acres in size and is situated southwest of Interstate 580, south of 82nd Avenue, and bisected by Fontaine Street. The King Estate Open Space Park property is mapped as the following vegetation communities/land cover types: annual grassland (61.1 acres), coastal oak woodland (12.0 acres), coastal scrub (4.3 acres), and urban (4.0 acres). The Oak Knoll Neighborhood Improvement Association is active in vegetation management efforts on the King Estate Open Space Park. The Association has assisted in grazing operations, identifying exclusion areas on the steep western slopes to minimize erosion and slope stability impacts. Local park stewards and OFD should coordinate with each other as needed, prior to any planned vegetation management activities so as to clarify management objectives, specific vegetation management activities, the timing of work activities, and other details. Please see Section 11.2 which describes the recommended communication and coordination protocol between OFD and local stewardship groups.

King Estate Open Space Park – red line represents park boundary, unmaintained private property is to the southwest.

Ignitions on the property are of concern given the proximity of homes, views from the property, and the significant coverage of ignitable grasses on site. OFD has noted that the use of fireworks on and around the property is prevalent on and around July 4 annually. Additionally, unmaintained areas on private property south of the site (behind properties on Aster Avenue) as well as areas owned by the Oakland Unified School District represent a high fuel load adjacent to the site. Acacia trees present along the western boundary of the park also contribute to the fuel load in this area. Fire behavior modeling resulted in isolated active crown fire only in coastal scrub where overstory trees are present and surface fire only throughout the remainder of the property.

King Estate Open Space Park – grazed grassland, oak woodland, and grass/shrub fuels

Current management practices include roadside treatment along Fontaine Street and Crest Avenue through the use of hand labor or mechanical techniques, and grazing throughout the property to reduce ladder fuels, control invasive species, and reduce and maintain surface fuel loads. Approximately 88 acres of the property are currently grazed annually. The perimeter of the property falls within the 100-foot and 300-foot buffers from existing structures.

The following recommendations were developed in consultation with the Oak Knoll Neighborhood Improvement Association to manage vegetation and reduce the fire risk at the King Estate Open Space Park. The following general management recommendations are provided for the King Estate Open Space Park:

- Maintain the existing trail/road networks to facilitate access and to create breaks in surface vegetation.
- Implement measures to prevent unauthorized vehicle access to the property's dirt access roads.
- Coordinate with Oakland Unified School District regarding vegetation management on adjoining property, where appropriate.
- Coordinate with private property owners regarding vegetation management on adjoining property, where appropriate.
- Avoid or minimize grazing on the steep western slopes to minimize erosion and slope stability impacts.
- Install signage at park entrances indicating that King Estate Open Space Park is a City of Oakland park, and notifying visitors of Park rules, including that campfires, fireworks, and other fire hazardous activities are prohibited.

The following specific projects have been identified for the King Estate Open Space Park:

- **KES-1:** Manage vegetation within 100 feet of structures, within 150 feet of park access gates, and within 30 feet of Fontaine Street and Crest Avenue according to the standards outlined in Section 9.1. Treatment area equals 15.6 acres. **Priority 1**.
- **KES-2:** Continue to manage vegetation via grazing throughout the remainder of the park to maintain fuel loads and minimize ignition potential, particularly prior to the 4th of July holiday. Treatment area equals 65.6 acres. **Priority 3.**

9.2.4.5 Other Open Space Areas

Tunnel Road Open Space – grassland (lower) and oak woodland (upper)

Other small City-owned parcels or groups of parcels that are not otherwise classified above but exhibit similar vegetation conditions and are currently managed by the City are summarized below. Current management practices include roadside treatment through the use of hand labor or mechanical techniques, and hand labor treatment, mechanical treatment, or grazing throughout each area to reduce ladder fuels, control invasive species, and reduce and maintain surface fuel loads. Continued management of these areas is recommended according to the standards outlined in Section 9.1. Local park stewards and OFD should coordinate with each other as needed, prior to any planned vegetation management activities so as to clarify management objectives, specific vegetation management activities, the timing of work activities, and other details. Please see Section 11.2 which describes the recommended communication and coordination protocol between OFD and local stewardship groups.

- **Blue Rock Court** – Collectively totaling 15.4 acres (annual grassland [2.2 acres], coastal oak woodland [5.1 acres], eucalyptus [8.0 acres], and urban [0.1 acres]), this area is located immediately north of Interstate 580, northwest of Blue Rock Court. Active and passive crown fire in the eucalyptus stand, surface fire only throughout the remainder of the property. No stewardship groups are active in vegetation management efforts on the Blue Rock Court property. The following specific projects have been identified for the Blue Rock Court property:

- **BLU-1:** Manage vegetation within 100 feet of structures and within 30 feet of fire access road along southern property edge according to the standards outlined in Section 9.1. Treatment area equals 2.4 acres. **Priority 1**.
- **BLU-2:** Implement brush and tree thinning recommendations in areas exhibiting extreme fire behavior and within 300 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 0.5 acres. **Priority 2**.
- **BLU-3:** Implement thinning recommendations in the property's eucalyptus stand beyond that treated under project BLU-2 according to the standards outlined in Section 9.1. Treatment area equals 6.4 acres. **Priority 3**.

- **Leona Street** – Collectively totaling 1.9 acres (annual grassland [0.1 acres], coastal oak woodland [1.5 acres], and eucalyptus [0.2 acres]), this area is a road extension at the east end of Leona Street. Surface fire only in coastal oak woodland and annual grassland. Active crown fire in eucalyptus stand at the property's southern end. No stewardship groups are active in vegetation management efforts on the Leona Street property. The following specific project has been identified for the Leona Street property:
  - **LST-1:** Manage vegetation within 100 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 0.4 acres. **Priority 1**.
- **McDonell Avenue** – Collectively totaling 1.1 acres (coastal oak woodland [0.6 acres] and urban [0.5 acres]), this area is a road extension at the east end of McDonell Avenue. Surface fire only. No stewardship groups are active in vegetation management efforts on the McDonell Avenue property. The following specific project has been identified for the McDonell Avenue property:
  - **MCD-1:** Manage vegetation within 100 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 0.9 acres. **Priority 1**.
- **Police/Safety Department Property** – Collectively totaling 11.3 acres (eucalyptus [7.9 acres] and urban [3.4 acres]), the eucalyptus stand is on the same parcel as the police/safety department site on Mountain Boulevard and is situated along the perimeter of the developed portion of the property. Surface fire only. The following specific projects have been identified for the Police/Safety Department property:
  - **PSD-1:** Manage vegetation within 100 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 7.2 acres. **Priority 1**.
  - **PSD-2:** Manage vegetation along adjacent roadside (Mountain Boulevard). Treatment width should be based on field observations, but not to exceed 30 feet. At a 30-foot width, the treatment area equals 0.5 acres. **Priority 1.**

- **Tunnel Road Open Space** – Collectively totaling 4.0 acres (annual grassland [1.2 acres], coastal oak woodland [2.7 acres], and urban [0.1 acres]), this area is along Tunnel Road, west of State Route 24. Surface fire only. No stewardship groups are active in vegetation management efforts on the Tunnel Road Open Space property. The following specific project has been identified for the Tunnel Road Open Space property:
  - **TRO-1:** Continue to manage vegetation via grazing throughout the property to minimize ignition potential from adjacent roadways. Treatment area equals 4.4 acres. **Priority 1**.
- **Marjorie Saunders Park** – Collectively totaling 3.6 acres (closed-cone pine-cypress [0.2 acres], coastal oak woodland [1.0 acres], and eucalyptus [2.4 acres]), this area is along Ascot Drive, southeast of Shepherd Park. Active and passive crown fire in the eucalyptus stands. Surface fire only throughout the remainder of the property. The Friends of Sausal Creek and Piedmont Pines Neighborhood Association stewardship groups are active in vegetation management efforts in Marjorie Saunders Park. The following specific projects have been identified for Marjorie Saunders Park:
  - **MJS-1:** Manage vegetation within 100 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 0.9 acres. **Priority 1**.
  - **MJS-2:** Implement brush and tree thinning recommendations in areas exhibiting extreme fire behavior and within 300 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 1.8 acres. **Priority 2**.
- **Oak Knoll** – Collectively totaling 15.7 acres (annual grassland [2.9 acres], eucalyptus [1.3 acres], coastal oak woodland [0.4 acres], and urban [11.1 acres]), this area is northeast of Mountain Boulevard and south of Keller Avenue. Surface fire only throughout the property. No stewardship groups are active in vegetation management efforts on the Oak Knoll property. The following specific project has been identified for the Beaconsfield Canyon property:
  - **OKN-1:** Manage vegetation within 100 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 1.2 acres. **Priority 1**.
  - **OKN-2:** Continue to manage vegetation via grazing throughout the remainder of the park to maintain fuel loads and minimize ignition potential. Treatment area equals 14.5 acres. **Priority 3.**

9.2.5 Other Areas

Other City-owned properties in the Plan Area that are not otherwise classified above include fire stations (nos. 6, 7, 21, 25 and 28), City facilities (parking lots, police stations), and developed parks and playgrounds (e.g., Montclair Park). This classification includes 43 properties encompassing 24.5 total acres. These properties are mapped as urban land cover types, fall entirely or largely within the 100-foot buffer from existing structures, and present a low fire risk as they are developed with irrigated and maintained landscaping. No current vegetation management activities are conducted on these parcels. No additional management recommendations are identified for these parcels; however, should conditions change (e.g., property abandoned and landscape vegetation dies) and hazardous conditions observed during annual field assessments, treatment should be conducted as identified for urban and residential parcels (Section 9.2.1). The locations of other areas are presented in Figure 5.

9.2.6 Roadside Treatment Areas and Medians

Grazed roadside treatment area along Golf Links Road

Roadside treatment areas include the area of land within 30 feet of the roadside edge (edge of pavement) for all roads in the Plan Area. The length of all roads in the Plan Area totals 308 miles. A portion of these are considered priority access/egress routes, which total 30 miles. Medians are similar to roadside treatment areas in that they are located adjacent to roads in the Plan Area. However, they differ in that they are distinct parcels owned by the City. In the Plan Area, there are 32 parcels classified as medians, which total 5.8 acres. Annually, vegetation management is conducted along all priority access/egress routes and within all medians. Current vegetation management along roadsides and within medians in the Plan Area is focused on reducing ladder fuels, controlling invasive species (e.g., broom), maintaining fuel loads, reducing ignitable surface fuels (e.g., grasses, weeds), and pruning tree canopies for vertical clearance through the use of hand labor or mechanical techniques and grazing.

The federally-listed Presidio clarkia is known to occur on City-owned medians in the vicinity of Skyline Boulevard and Chadbourne Way (USFWS 2010). This species also occurs on roadsides nearby, specifically along the north side of Kimberlin Heights Drive, Colgett Drive, and Crestmont Drive at the junction with Westfield Way (USFWS 2010). Vegetation management activities in these areas should be timed to occur either before emergence or following seed-set of this species.

Priority roadsides (30 miles) and all medians (5.7 acres) are considered Priority 1 treatment areas (as defined in Section 9.3.3). The remaining roadside areas (278 miles) are considered Priority 2 treatment areas (as defined in Section 9.3.3). It is recommended that these areas and parcels continue to be managed according to the standards outlined in Section 9.1. The locations of roadside areas and medians are presented in Figure 5.

9.3 Property Assessment, Identification of Treatment Needs, and Work Plan Development

This section outlines the components of evaluating, prioritizing, and planning vegetation management actions to be conducted in the Plan Area. While this section identifies preparation of an annual work plan to address vegetation management needs, regular and routine field inspections by OFD staff may necessitate modifications to the annual work plan.

9.3.1 Field Assessments

Field assessments of vegetation conditions in the Plan Area will be conducted by OFD staff in the spring months, although the exact dates of assessments will vary depending on weather conditions (e.g., annual rainfall, number of hot, dry days). The intent of field assessments is to inform the work plan development process by identifying the anticipated level of effort necessary to treat vegetation in the Plan Area and to identify which vegetation management techniques will be employed.

OFD also routinely patrols the Plan Area to inspect vegetation conditions and monitor the progress of treatment activities. This effort will continue and may result in recommendations to modify the annual work plan such that management standards are met. For example, vegetation that dies and cures on a property that has already been treated would require retreatment to meet identified management standards.

9.3.2 Treatment Timing

The timing of vegetation treatments is important to achieve the identified vegetation management standards. Given the variable nature of vegetation through changes in weather and season, the schedule of the treatment may often be just as important as the type of treatment selected. For example, treatments in grasslands typically take place when grass cures or dries out. Cutting grass too early will be ineffective as the grass typically grows back, effectively negating the treatment. Conversely, cutting grass too late will leave the grass in a hazardous condition during periods of high fire danger. Vegetation treatments also need to be conducted when the weather is not too dry or windy, as some treatment techniques (e.g., mechanical treatments) have the potential to ignite fires.

Treatment timing can also be used to avoid or minimize impacts to special-status plant and animal species. Given the species identified in the Plan Area, it is likely that there will be some periods at some locations when vegetation management activities need to be avoided (e.g., nesting season). Timing treatments to either control or avoid the spread of high fire risk plants such as broom or pampas/jubata grass or insect pests is also critical. For example, treatments performed when plants have set or are setting seed will allow for greater seed dispersal. Treatment timing should therefore take advantage of differences in the timing of seeding of fire-resistant plant species and avoid periods when invasive or pyrophytic species are in seed. Table 10 summarizes treatment timing considerations for minimizing seed spread of high fire risk plants. Tree pruning should also be done when insect pests are not flying to minimize potential spread and resulting damage to other trees.

Table 10
Treatment Timing Considerations to Minimize Rapidly Spreading/ Highly Flammable Species Spread

Plant	Month											
	Jan.	*Feb.*	*Mar.*	*Apr.*	*May*	*Jun.*	*Jul.*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
French broom	1	1	1	1	2	2	3	3				
Spanish broom				1	1	2	3	3				
Acacia		1	1	1	1	1	3	3	3			
Blackberry				3	3	3	1	1	1			
Eucalyptus	1	1	3	3	3	3	3	3	3	3		1
Yellow star-thistle					1	1	1	3	3	3		
Hemlock				1	1	3	3	3				
Spurge			1	1	1	1	2	2				
Fennel					1	1	1	1	3	3		
Milk thistle					1	1	3	3	3			

Source: LSA 2010.

1	Conduct treatments during this time to avoid spreading seed
2	Use caution; treatments may spread seed if not contained
3	Use extreme caution or avoid treatments; seed spread likely if not contained

The timing of vegetation management treatments shall be based on the results of the field assessments conducted by OFD staff. Typically, treatments will begin annually in the spring and early summer months, but timing may be adjusted according to weather (e.g., temperature, precipitation) or other site-specific factors. Vegetation treatments may also be conducted more than once annually, depending on site conditions and the results of subsequent assessments. The order in which properties are treated may also be adjusted according to field observations, with areas exhibiting more hazardous conditions being treated before those exhibiting less hazardous conditions. The availability of resources (e.g., goat herds) may also influence treatment timing; however, efforts shall be made to prioritize treatment of areas exhibiting more hazardous conditions.

9.3.3 Treatment Prioritization

Given the variability of parcel size and distribution, terrain characteristics, vegetative fuel cover, and potential fire behavior across the Plan Area, uniform application of vegetation management standards is not feasible. Treatment areas were therefore prioritized as presented below and based on the wildfire hazard assessment conducted in support of this VMP. During its annual field assessment effort and work plan development process, OFD will identify the areas requiring treatment, the type and extent of treatment necessary, and will prioritize treatment as outlined below. The geographic extent of priority areas was determined in a GIS such that treatment acreages could be calculated for parcels and parcel groups (e.g., large parks), as presented in Appendix H. Appendix H summarizes the acreages of recommended treatment areas, by parcel/park location and by priority number. Section 12.6 also provides a list of recommended treatment area, organized by priority category. Figures 6.1 through 6.10 presents the locations of the project areas prioritized as described below and further detailed in Appendix H.

Priority 1

Priority 1 areas include those where annual vegetation management activities should be focused first and include:

- The area within up to 100 feet of structures or critical infrastructure (e.g., water supplies, communications facilities) in the Plan Area. This treatment area provides defensible space for existing structures and reduces fire intensity at the wildland urban interface. This buffer distance (100 feet) is also consistent with state level standards for defensible space (PRC 4291). This area may be reduced based on field observations during annual field assessments, or where otherwise recommended (e.g., riparian areas).
- The area within up to 30 feet from roadside edges (including City-owned medians) along major access/egress routes in the Plan Area. Roadsides are of concern because wildfires are generally started by human activity (e.g., sparks, catalytic converters, tossed cigarettes). Roadside vegetation management along these routes also enhances greater egress and ingress in the event of an emergency. This area may be reduced based on field observations during annual field assessments, or where otherwise recommended (e.g., riparian areas).
- The area within 300 feet of ridgelines. Ridgelines are of concern due to the potential for high and erratic winds and the potential for spotting should crown fire occur. This treatment

area is intended to reduce fuel loads and ladder fuels where strong and erratic winds would be expected. This buffer distance (300 feet) is also consistent with community fuel break and structure protection standards (14 CCR 103 (c)(6), Diablo Firesafe Council 2015).

- The area of land within 150 feet of park access gates to function as fire response anchor points to promote firefighter safety.
- Areas where vegetation management will contribute to multi-jurisdictional regional fuel breaks. In collaboration with other land owners and managers, vegetation management that enhances the fuel break network in the Oakland Hills allows for more effective containment and suppression activities should a wildfire occur.
- The area within up to 30-foot buffer around known/historic sources, areas, or sites of ignition. This treatment effort is intended to minimize wildfire ignitions originating from human activity. This area may be reduced based on field observations during annual field assessments.

Priority 2

Priority 2 areas include those where annual vegetation management activities should be focused once Priority 1 areas have been completed or if schedules and budgets allow for completion in addition to Priority 1 areas. Priority 2 areas include:

- The area within up to 30 feet from roadside edges along all other roads in the Plan Area not included in Priority 1. This area may be reduced based on field observations during annual field assessments.
- Areas between 100 feet and 300 feet from structures where modeled fire behavior exhibits crown fire or flame lengths in excess of 8 feet. Defensible space areas (0 to 100 feet from structures) are addressed under Priority 1. Treatment in this area is intended to minimize extreme fire behavior in areas near existing structures, also reducing spotting potential from crown fires that may ignite vegetation or structures at considerable distances from the fire. This buffer distance (300 feet) is also consistent with community fuel break and structure protection standards (14 CCR 103 (c)(6), Diablo Firesafe Council 2015).

Priority 3

Priority 3 areas include those where annual vegetation management activities should be focused once Priority 1 and 2 areas have been completed or if schedules and budgets allow for completion in addition to Priority 1 and 2 areas. Priority 3 areas include:

- Areas that are currently being managed under the City's goat grazing program not identified for management under Priorities 1 and 2. The intent of this management activity is to maintain lower fuel loads within larger park lands or open space areas in the Plan Area.

- Removal of highly flammable plants species from oak woodland vegetation communities to reduce fuel loading rates.

9.3.4 Treatment Technique Selection

Treatment method selection is dependent on the dominant vegetation type being treated. Treatment may focus on grasses and surface fuels, brush or scrub, trees, or highly flammable plants, each of which require different tools and techniques that can be employed to reach management standards, and multiple techniques may be employed on a property during treatment operations. Vegetation management technique selection shall be made from those identified in this VMP and will be based on the condition of vegetation observed during field assessments. Treatment techniques, or combinations thereof, will be identified in the annual work plans prepared by OFD.

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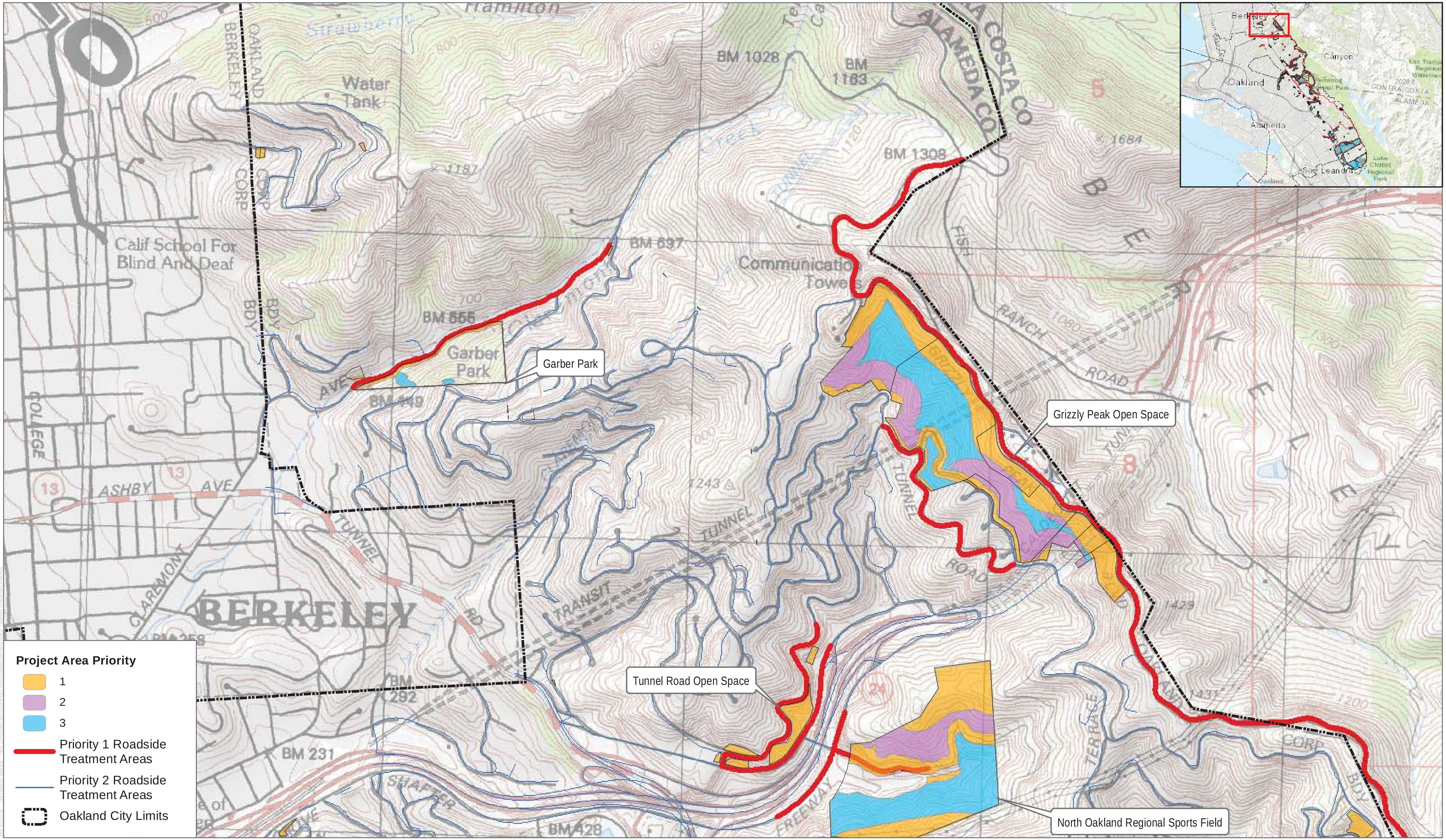

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

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FIGURE 6.1

Project Location Map

Revised Draft Vegetation Management Plan - City of Oakland, California

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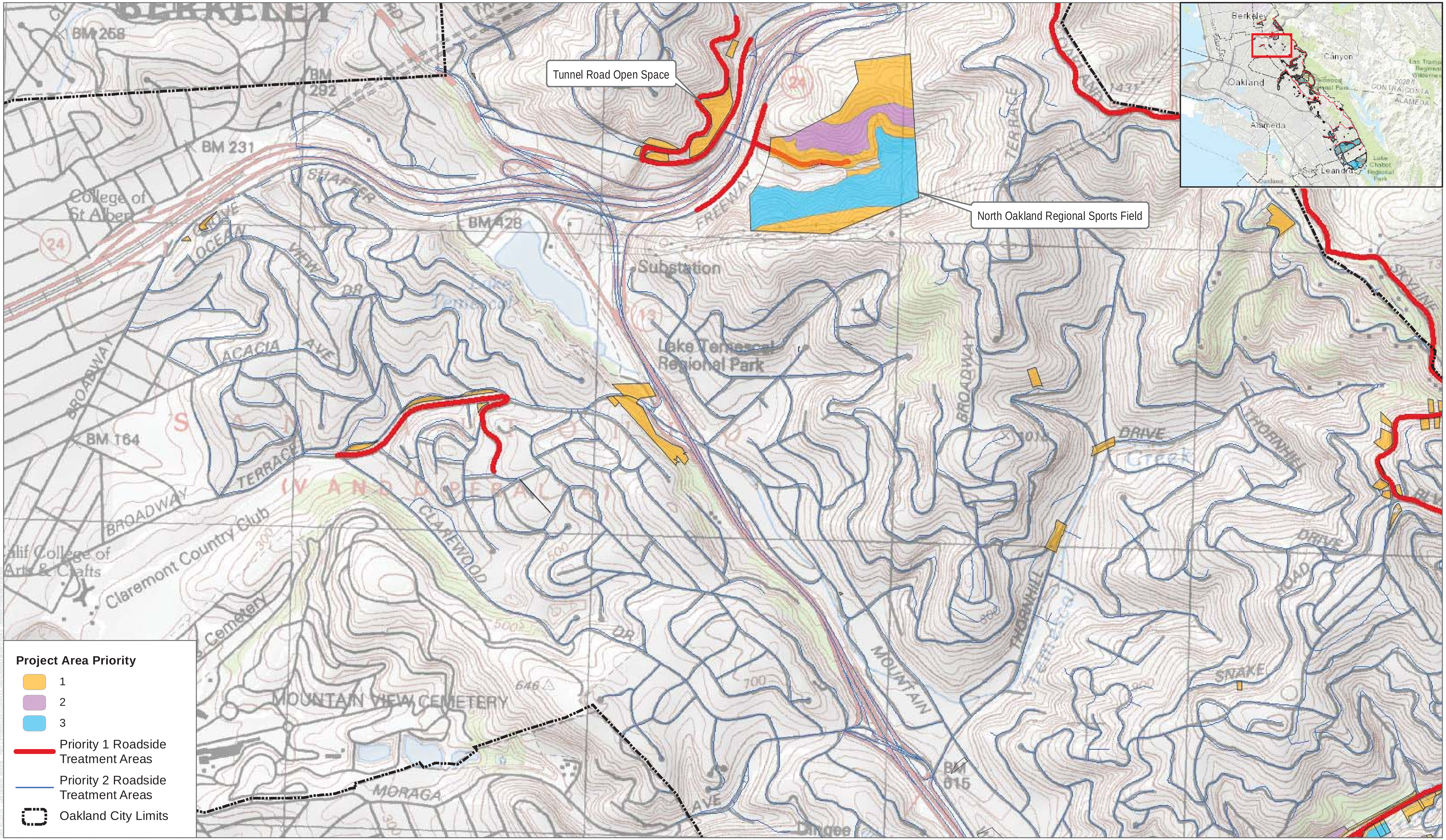

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

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FIGURE 6.2

Project Location Map

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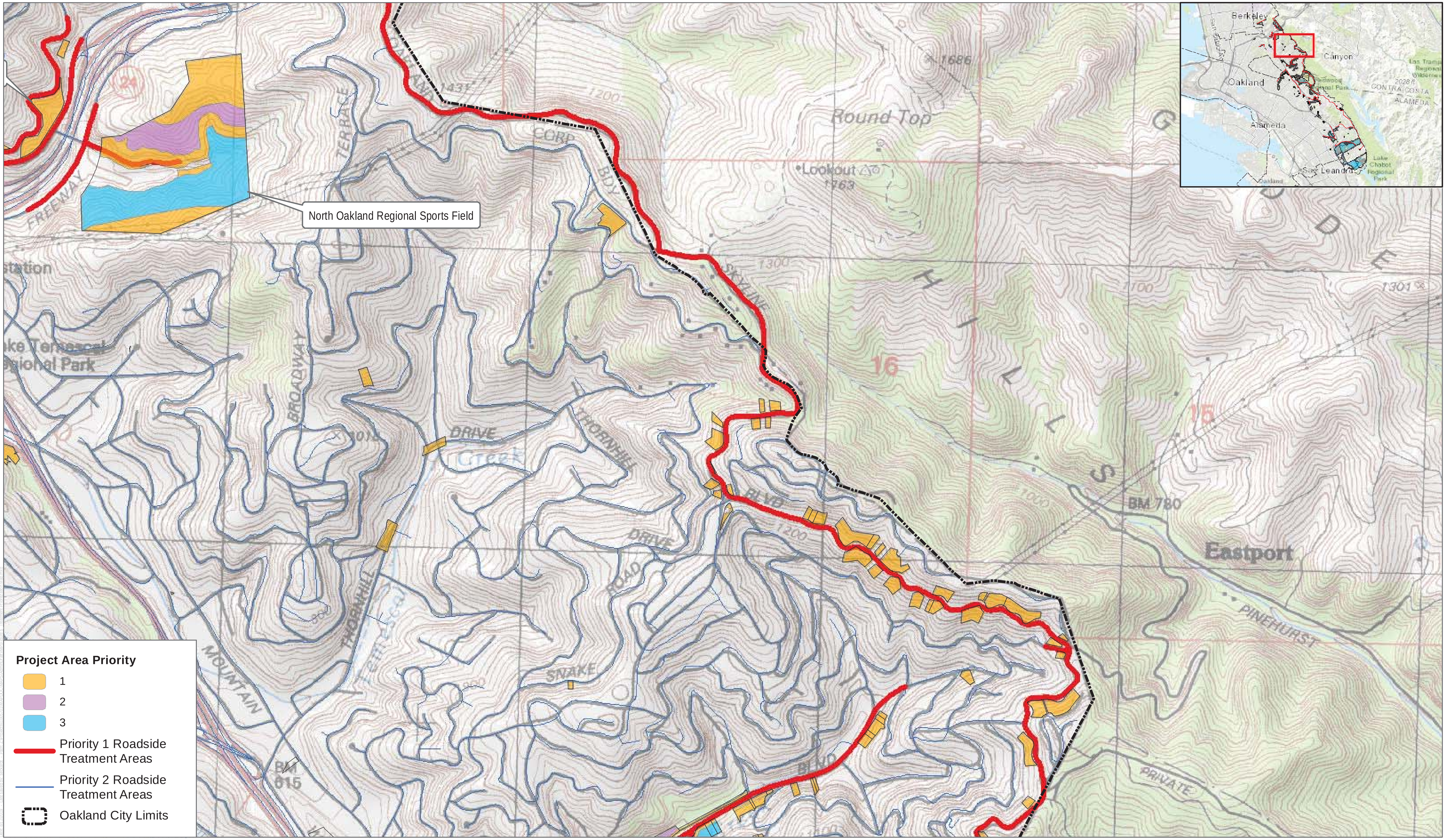

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

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FIGURE 6.3

Project Location Map

Revised Draft Vegetation Management Plan - City of Oakland, California

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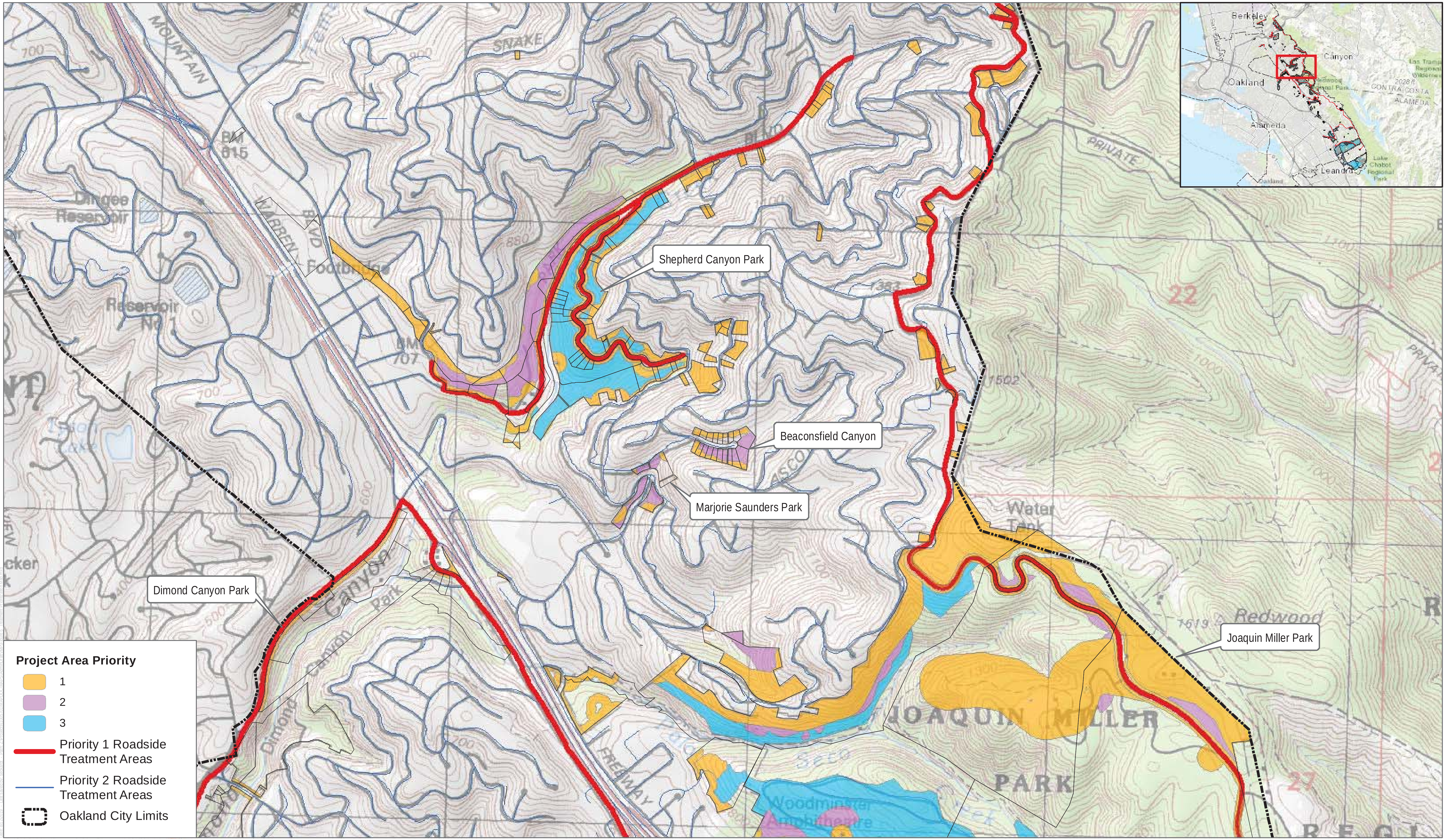

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

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FIGURE 6.4

Project Location Map

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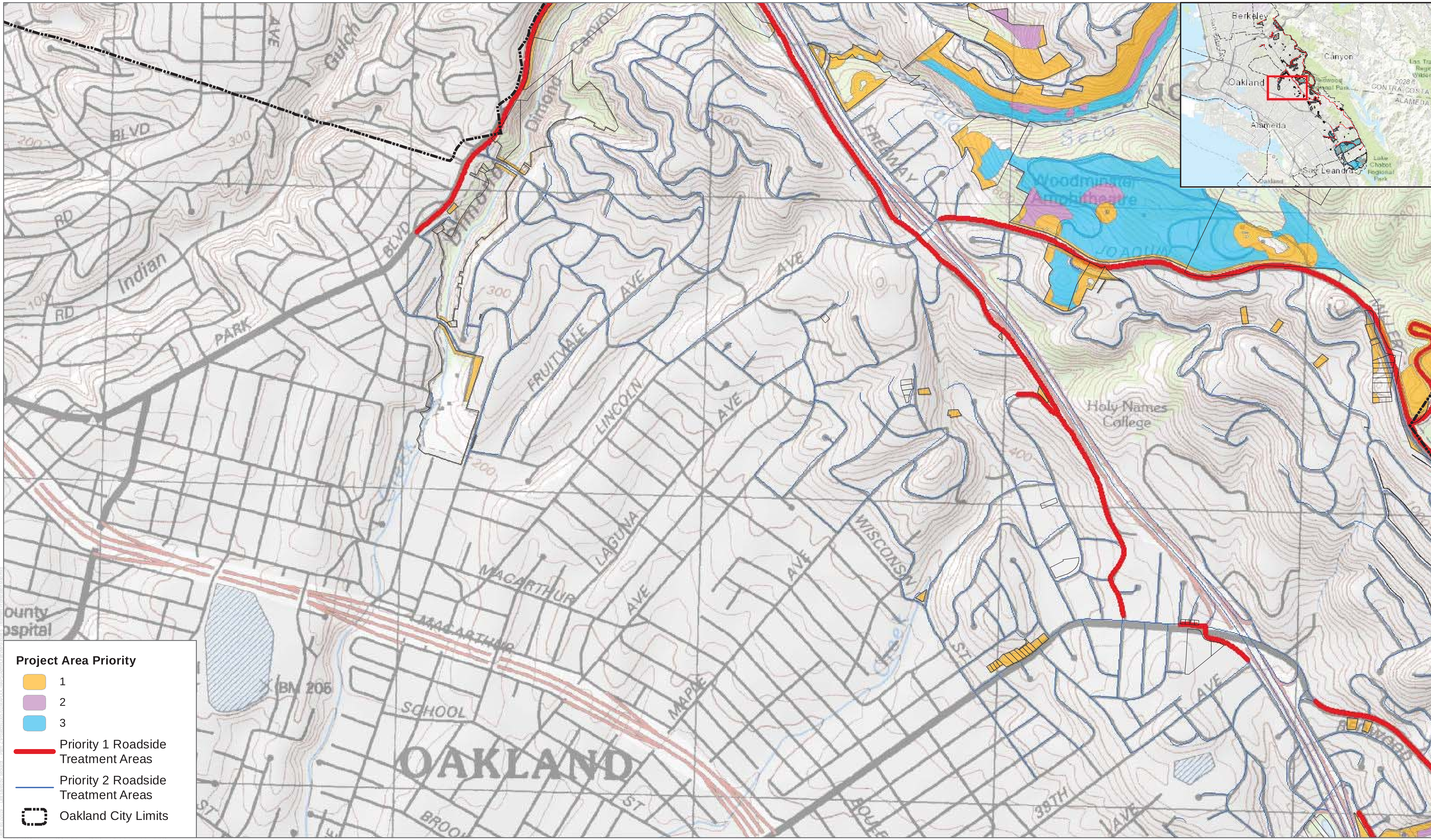

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

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FIGURE 6.5

Project Location Map

Revised Draft Vegetation Management Plan - City of Oakland, California

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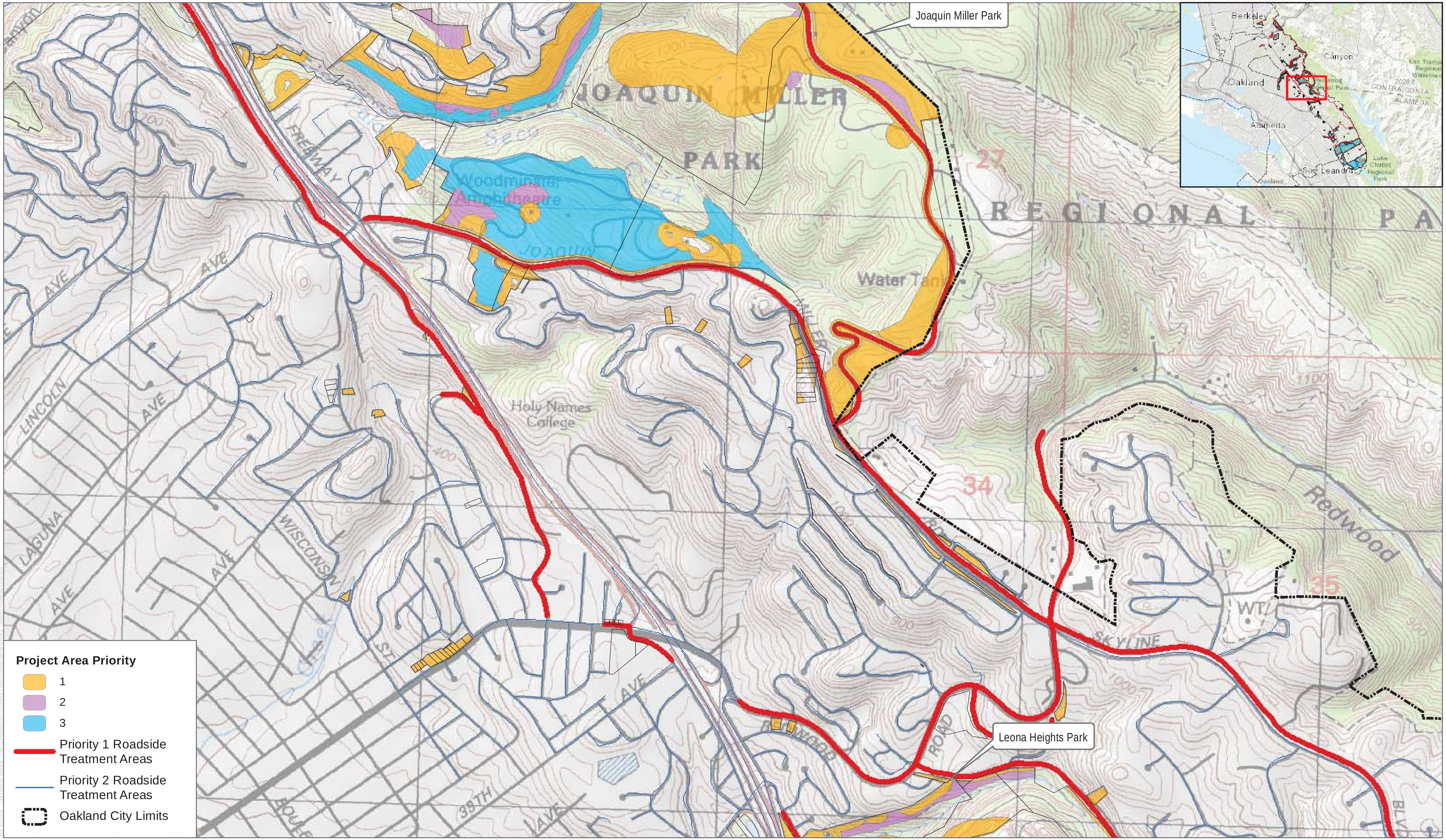

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

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FIGURE 6.6

Project Location Map

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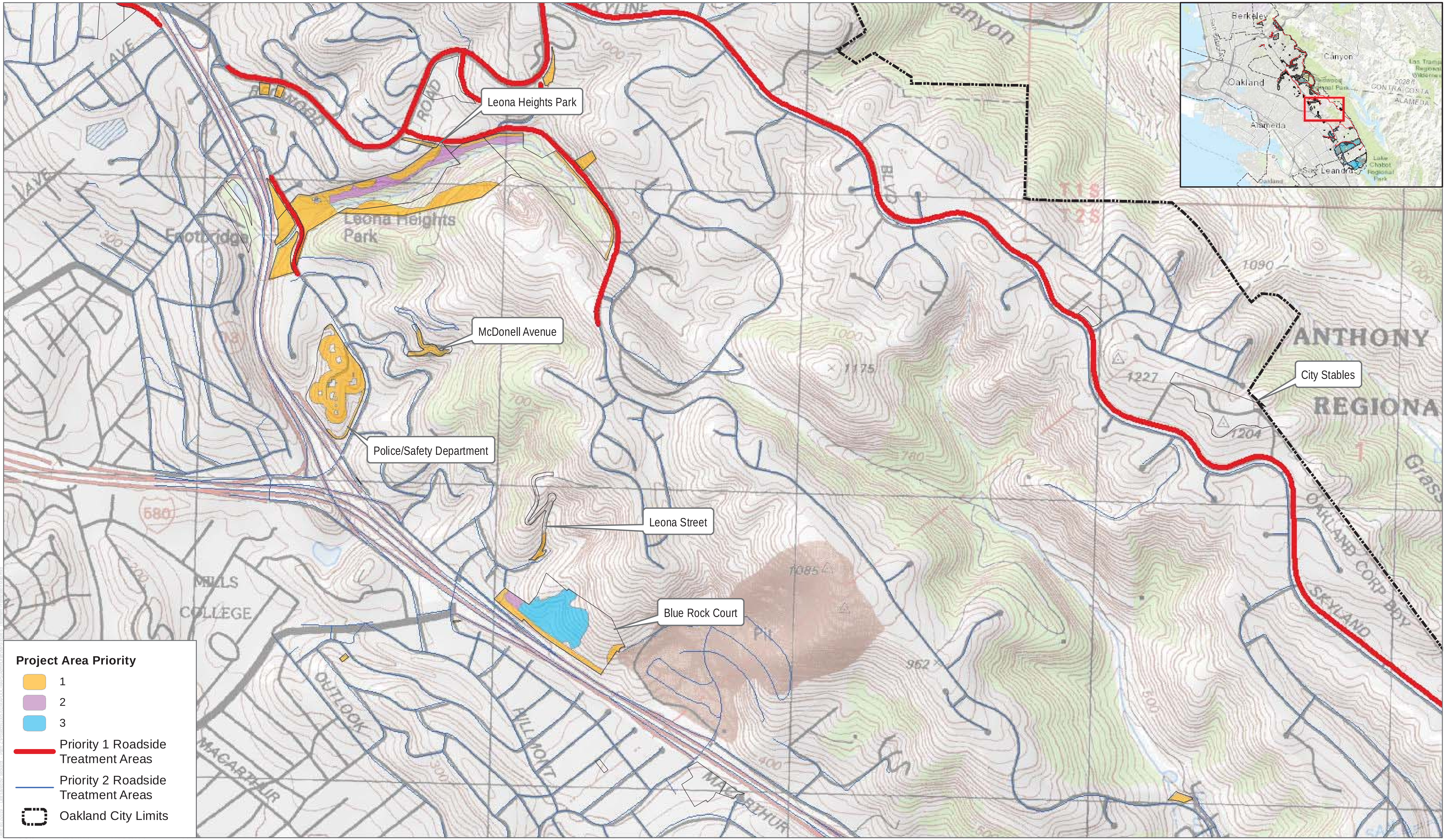

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

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FIGURE 6.7

Project Location Map

Revised Draft Vegetation Management Plan - City of Oakland, California

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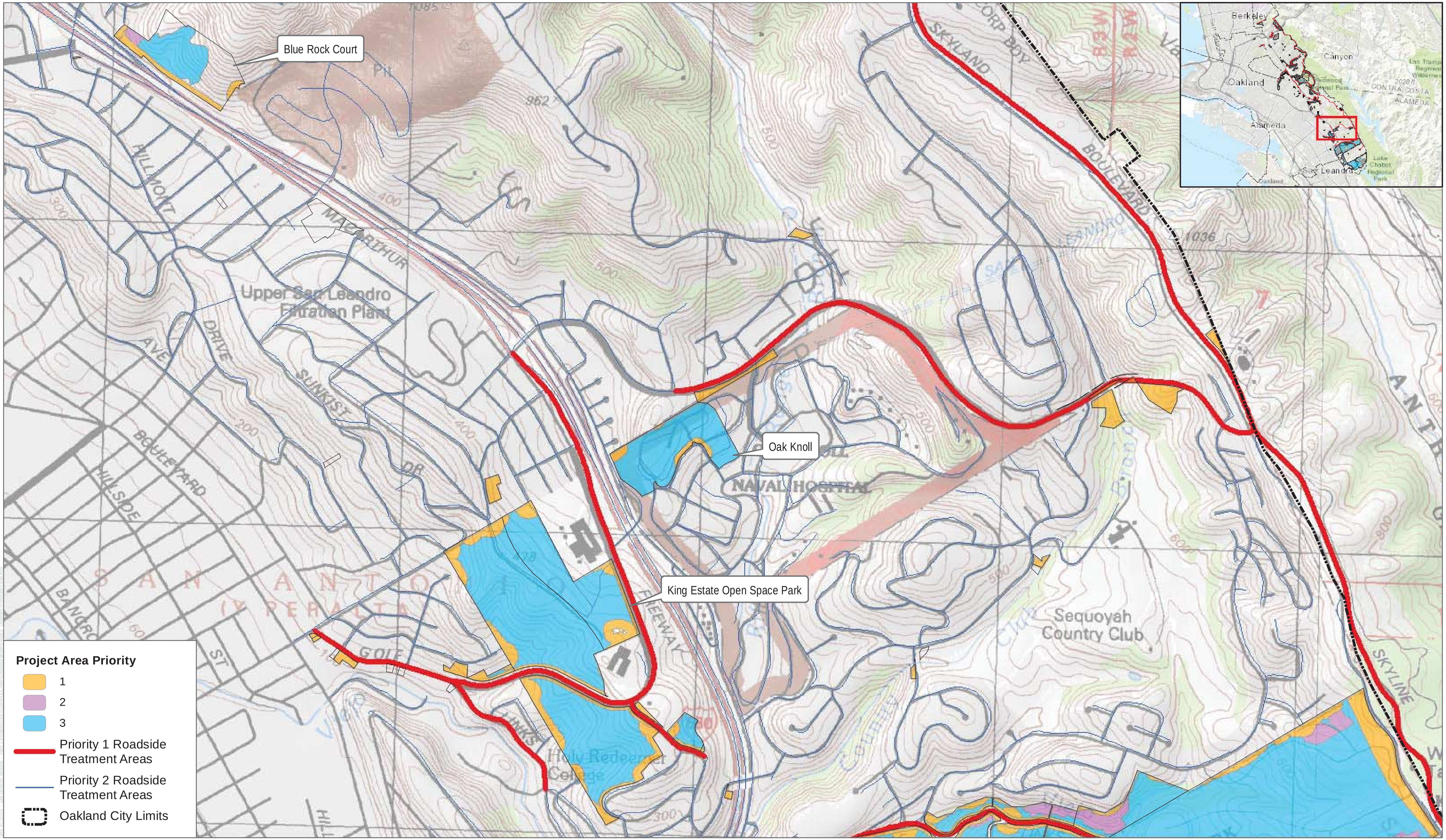

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

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FIGURE 6.8

Project Location Map

Revised Draft Vegetation Management Plan - City of Oakland, California

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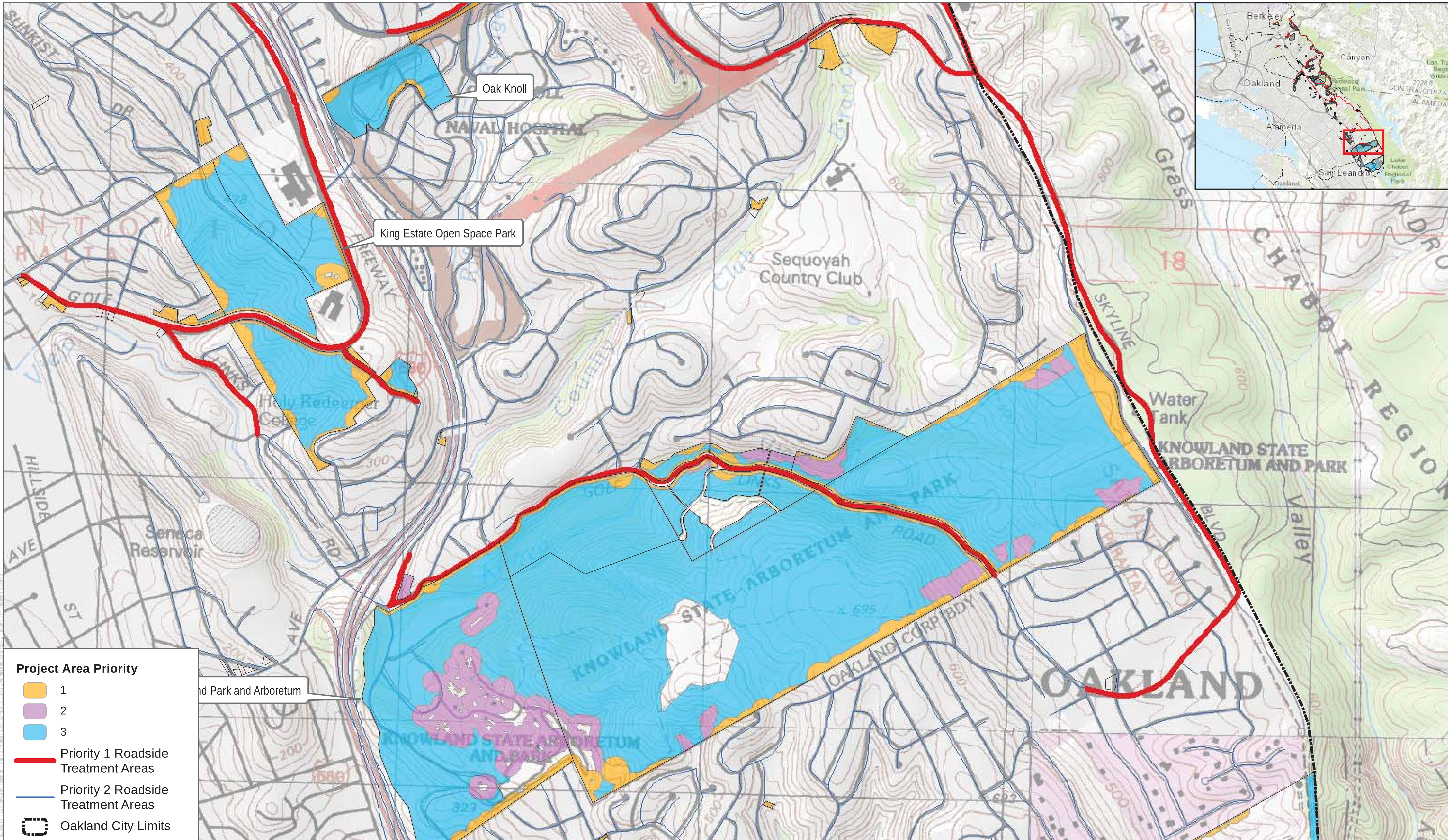

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

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FIGURE 6.9

Project Location Map

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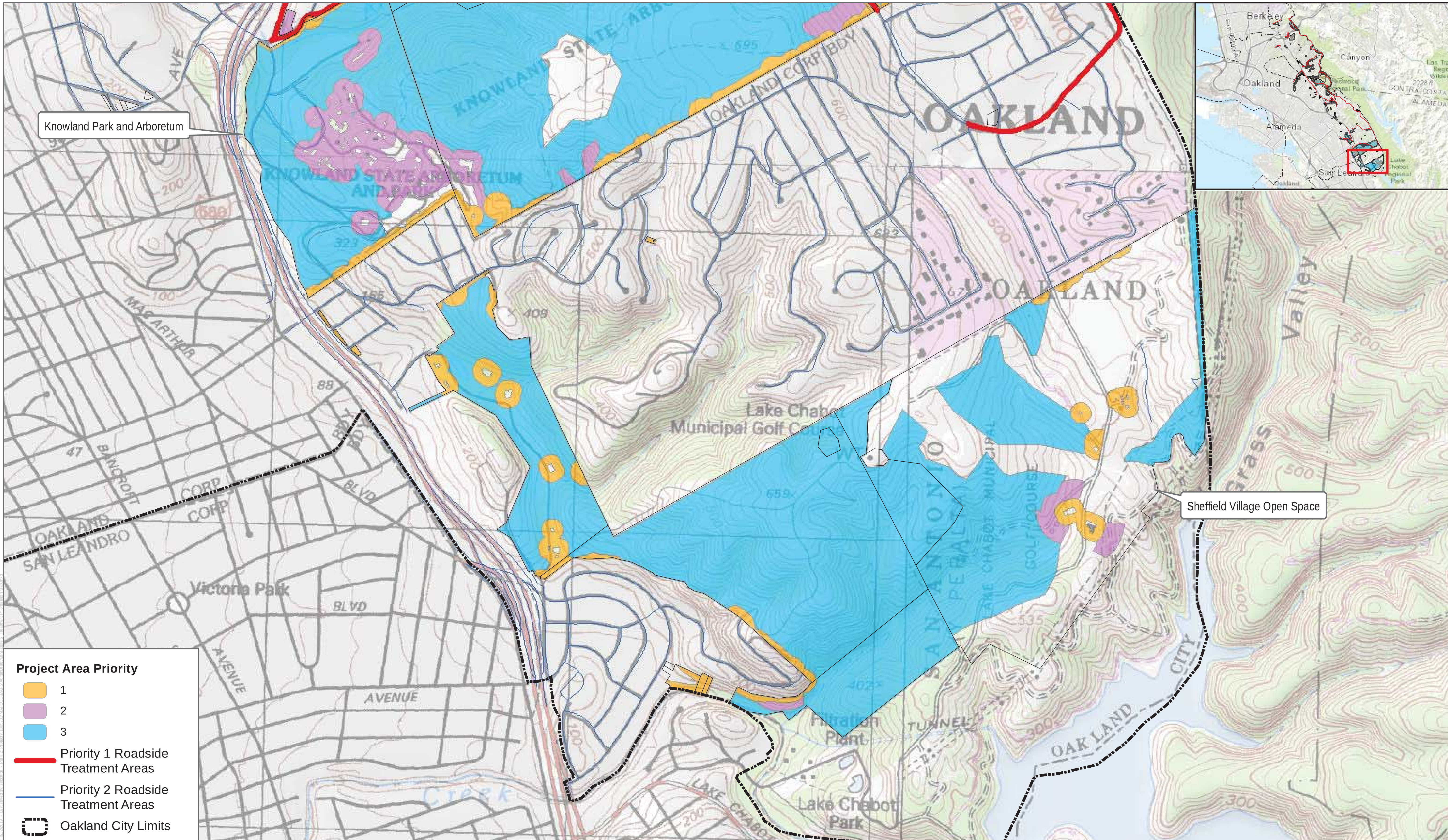

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

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FIGURE 6.10

Project Location Map

Revised Draft Vegetation Management Plan - City of Oakland, California

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9.3.5 Annual Work Plan Development

OFD will prepare annual vegetation management work plans based on the site-specific conditions observed during field inspections. The work plans will identify vegetation treatment types, area or properties to be treated, implementation timing, resource needs and availability, funding sources, and monitoring and tracking needs. This process will also involve preparing bid specifications, advertising bids, and evaluating and selecting qualified contractors, as necessary. Utilization of multi-year contracts may be beneficial for continuity and consistency and should be considered. OFD will also outreach to local volunteer/park stewardship groups, coordinate with other City departments, and coordinate with other agencies or landowners, as appropriate, during annual work plan development.

This VMP includes an adaptive management component; therefore, the annual work plan is intended to be an internal, working document that may be modified throughout the year. Modifications to the annual work plan may be necessary due to various factors, including field conditions, weather, vegetation growth, contractor or crew completion rates, staff and resource availability, permit acquisition needs, and emergency conditions, among others.

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10 PRACTICES TO AVOID/MINIMIZE IMPACTS

In addition to the BMPs identified for the vegetation management techniques identified in this VMP, this section outlines additional practices intended to avoid or minimize potential impacts associated with vegetation treatment or removal. BMPs for general operations, vegetation management, and protection of biological resources are also provided in Appendix I.

10.1 Stormwater/Erosion Control

The vegetation treatment techniques identified in this VMP have the potential to affect soil stability. Soil stability may be indirectly affected by the removal of overstory vegetative cover, which reduces rainfall interception and thereby increases its surface erosion potential. This may result in the detachment and transportation of soil particles across the soil surface. Soil stability may also be directly affected by through the use of heavy equipment, tools, hand crews, or livestock, all of which can loosen, dislodge, or compact soils. This too can increase the potential for detachment and transportation of soil particles across the soil surface.

A procedure has been developed by the California State Board of Forestry (California State Board of Forestry 1990) to estimate a surface soil erosion hazard rating that considers soil characteristics (texture, depth to restrictive layer, percent of coarse surface fragments), slope, vegetative cover, and precipitation. The hazard rating is designed to evaluate the susceptibility of the soil within a given location to erosion. This rating should be determined and considered on a site-specific basis when determining the needs for erosion control BMPs in the Plan Area. In addition, areas where erosion has occurred in the past due to vegetation management activities should be avoided, or alternative methods implemented to minimize potential impacts to soil stability.

BMP Practices and Devices

There are various erosion control practices and devices available for slowing the rate of erosion. Recent research indicates that mechanical rehabilitation treatments, including straw mulch, hay bales, and jute rolls are more predictable for reducing soil erosion and post-fire hydrological problems than seeding or other treatments (Robichaud et al. 2010). Mulching may introduce exotic/weed seeds (Kruse et al. 2004) if brought in from off site (as opposed to chipped on-site material), so erosion potential should be high before the decision to use this material is finalized.

Numerous BMPs have been developed for use in erosion and sediment control, as identified by the Clean Water Program Alameda County (2009) which provides copies of the *California Stormwater BMP Handbook* (originally published by the California Stormwater Quality Association). This handbook presents detailed information regarding the implementation, maintenance, suitability, and limitations of different BMPs. The need for BMPs should be determined during annual work plan development or during subsequent monitoring efforts and should consider erosion hazard rating and/or the history of on-site erosion. Table 11 identifies the different BMP types for erosion and sediment control, as provided by the Clean Water Program Alameda County (2009). Detailed information can be found at the following address:

https://www.cleanwaterprogram.org/index.php/businesses/construction.html.

Table 11
Erosion and Sediment Control BMPs

Erosion Control		Sediment Control	
Hydraulic Mulch	Velocity Dissipation Devices	Silt Fence	Sandbag Barrier
Hydroseeding	Slope Drains	Sediment Basin	Straw Bale Barrier
Soil Binders	Streambank Stabilization	Sediment Trap	Storm Drain Inlet Protection
Straw Mulch	Compost Blankets	Check Dam	Active Treatment Systems
Geotextiles and Mats	Soil Roughening	Fiber Rolls	Temp Silt Dike
Wood Mulching	Non-vegetation Stabilization	Gravel Bag Berm	Compost Socks and Berms
Earth Dikes and Drainage Swales		Street Sweeping and Vacuuming	Biofilter Bags

Source: 2017 California Forest Practice Rules (14 CCR, Chapters 4, 4.5, and 10).

In the event that a wildfire event occurs in the Plan Area, stabilization of soils in the burn area is a primary concern, especially in areas with steep slope gradients. Erosion control BMPs should be installed as soon as possible and prior to the onset of the winter period (October 15 to April 1).

Access Roads

In areas where existing dirt access roads will be retained, waterbreaks[8] and drainage structures should be constructed to minimize erosion potential. All waterbreaks and drainage structures should be installed no later than the beginning of the winter period (October 15 to April 1). Outside the winter period, waterbreaks and drainage structures should be installed prior to sunset if the National Weather Service forecast is a "chance" (30% or more) of rain within the next 24 hours. Waterbreaks should be constructed immediately upon conclusion of use of access roads which do not have permanent and adequate drainage structures. Distances between waterbreaks should

8 A waterbreak (or waterbar) is a shallow trench with a parallel berm or ridge on the downslope side, angled downward across a road and installed to control surface runoff.

adhere to the standards outlined in Table 12. Access roads should be closed to public vehicle travel following completion of vegetation treatment operations.

Table 12
Maximum Distance between Waterbreaks

Estimated Erosion Hazard Rating	Road Slope Gradient (percent)			
	≤10	*11–25*	*26–50*	*>50*
Extreme	100	75	50	50
High	150	100	75	50
Moderate	200	150	100	75
Low	300	200	150	100

Source: 2017 California Forest Practice Rules (14 CCR, Chapters 4, 4.5, and 10).

10.2 Watercourses

The purpose and intent of the City of Oakland's Creek Protection Ordinance (Oakland Municipal Code Chapter 13.16) is:

- Safeguarding and preserving creeks and riparian corridors in a natural state;
- Preserving and enhancing creekside vegetation and wildlife;
- Preventing activities that would contribute significantly to flooding, erosion or sedimentation, or that would destroy riparian areas or would inhibit their restoration;
- Enhancing recreational and beneficial uses of creeks;
- Controlling erosion and sedimentation;
- Protecting drainage facilities; and
- Protecting the public health and safety, and public and private property.

The ordinance includes permitting guidelines for development and construction projects taking place in or near creeks. This includes the clearing of vegetation for wildfire hazard reduction purposes. Vegetation management activities on any creekside property would require a Creek Protection Permit. Creekside properties are defined as properties located within Oakland, as identified by the Environmental Services Manager, which have a creek or riparian corridor crossing the property and/or are contiguous to a creek or riparian corridor. The intent is to assure that work done will avoid or limit, to the extent feasible, negative impacts to creeks. The primary measure to minimize impacts to creeks and other water courses in the Plan Area is avoidance, meaning all work should be conducted outside of creekside properties. Should it be necessary to conduct vegetation management activities within creekside properties, OFD shall obtain a Creek Protection Permit, as outlined in Oakland Municipal Code Chapter 13.16.

10.3 Revegetation

Revegetation of areas subject to vegetation treatment or removal can minimize the potential for erosion by stabilizing soils. Revegetation is recommended only in areas where disturbed and/or bare soil exists following vegetation management operations as a measure to stabilize soils. The need for revegetation should be determined during annual work plan development or during subsequent monitoring efforts and should consider slope, soil type, access, irrigation and maintenance needs, and other BMPs being implemented on site. OFD should consult with qualified professionals (e.g., landscape architects, revegetation specialists) to develop site-specific revegetation plans, as appropriate. Revegetation may include hydroseeding (as presented in Section 10.1), direct seeding, or container plant installation. Plant species selection should be consistent with revegetation goals and should consider erosion protection value (e.g., deep-rooted species). Pyrophytic species should not be used for revegetation purposes.

10.4 Special-status Plant Communities/Species

The OFD's Draft Protected and Endangered Species Policy and Procedures document (Appendix J) establishes a uniform procedure for the protection of endangered or threated species of flora while conducting vegetation management activities in the Plan Area. The Draft document (Appendix J) outlines policies to ensure that endangered plant species are protected during vegetation management activities. These policies include requirements for contracting with qualified biological consultants to identify locations where such species exist, flagging avoidance areas, notifying contractors of avoidance areas during the contact bid phase, modifying vegetation treatment timing to promote seeding, obtaining agency permits, communicating with other City departments regarding vegetation management activities, and requiring that contractors do not impact or disturb areas designated for preservation.

10.5 Special-Status Wildlife Species

The vegetation management activities identified in this VMP have the potential to impact special-status wildlife via ground disturbance, vegetation removal or treatment, the use of vegetation management tools and equipment, or by increasing human presence within or adjacent to treatment areas. The special-status wildlife species with the potential to occur in the Plan Area are presented in Section 7.1.3. In order to minimize the potential for impacts to special-status wildlife species, the specific measures identified in Appendix I should be implemented, depending on wildlife species present in the identified treatment area. In general, these measures include conducting preconstruction biological surveys, identifying and marking avoidance or buffer areas, conducting biological monitoring during vegetation management operations, and establishing work windows to avoid and minimize adverse effects on nesting birds and special-status plants and animals. In order to facilitate implementation of the special-status wildlife species avoidance measures, OFD should contract with qualified biological consultants.

10.6 Pests/Pathogens

Pest and pathogen BMPs should be incorporated where applicable within the Plan area. These practices encompass both protection of the residual stand from mechanical damage, and quarantine and sanitation practices (described below). Outbreaks of known invasive pathogens such as SOD, well known for its detrimental impacts to oak populations along the west coast, and unknown pests and pathogens pose a threat to Plan Area forests. Sanitation of tools and equipment within the Plan Area should be conducted to reduce the spread of pests and diseases following treatments of areas of known infestation. If soil is collected on equipment, rinsing the equipment on site with a portable water tank or water truck, or at a designated rinsing station, can remove soil-borne pathogens and prevent transport to new sites. Additionally, certain pathogen-specific measures have been developed to deal with regional pathogens, namely pitch canker and SOD. These measures should be implemented in the Plan Area, where applicable. Specific measures can be found at the following links:

- Pitch canker: http://ufei.calpoly.edu/pitch_canker/management.lasso
- SOD: http://ipm.ucanr.edu/PMG/PESTNOTES/pn74151.html

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11 PLAN COORDINATION AND PARTNERSHIPS

The vegetation management actions identified in this VMP serve to address fire hazard in the Plan Area and contribute to regional efforts to mitigate wildfire hazard in the City's VHFHSZ and the Oakland Hills. OFD has a history of maintaining relationships and partnerships with other landowners and land managers that routinely treat vegetation for fire hazard reduction purposes and with community groups that seek to address fire hazard conditions in the Oakland Hills. In some cases, City property abuts land managed for fuel reduction purposes such that cohesive fuel breaks can be maintained. Advantages of such relationships and partnerships include:

- Information and data sharing;
- Resource sharing;
- Coordination of management activities;
- Facilitating property access;
- Grant funding and cost-sharing opportunities.

OFD routinely coordinates with the other City departments and with the following landowners or land managers: EBRPD, EBMUD, the California Department of Transportation, Pacific Gas and Electric (PG&E), Contra Costa County Fire Protection District, and the University of California, Berkeley. PG&E has recently increased vegetation management around its lines following recent destructive wildfires in northern California, as required by the California Public Utilities Commission. OFD also engages with local stakeholder/volunteer groups focused on fire hazard reduction, including the Hills Emergency Forum and the Oakland Firesafe Council. OFD also engages with local homeowners associations to discuss fuels reduction abatement on common area parcels and to discuss best practices for defensible space, assist homeowners associations in applying for Fire Safe Council abatement grants and complete annual inspections of the grounds.

This VMP recognizes that coordination with multiple agencies and stakeholders is a critically important component in addressing regional fire hazard conditions and recommends that coordination be continued over the course of the plan timeframe. The following sections summarize City departments and stakeholder/volunteer groups that have an interest in, and participate in, vegetation management on City-owned parcels.

11.1 City Departments

The following City departments have an interest in or otherwise manage vegetation on City-owned properties in the Plan Area. Consultation with these departments during annual work plan development is recommended to streamline efforts and maximize the use of available City resources:

- Parks, Recreation, and Youth Development Department: provides recreation and youth development programs and services to over 95,000 enrolled participants and over a million drop-in users annually through a wide variety of recreation, leisure, cultural, educational and environmental programs and activities for all ages.
- Public Works Department
  - Park Services and City Landscapes: responsible for the maintenance of parks, medians, waterfront trails and open space properties in Oakland. Park maintenance includes litter pickup and removal, pruning, weeding, turf mowing, irrigation system repairs and planting.
  - Tree Services and Urban Forestry: custodian of Oakland's urban forest. Currently performs tree trimming and removals based upon hazardous tree assessments and on emergency basis only.
  - Environmental Protection and Compliance: dedicated to improving the quality of City of Oakland facilities, open spaces, rights-of-way, waterways and development projects through professional environmental assessments and cleanups, implementation of best management practices, coordination of volunteer beautification efforts and education.

11.2 Coordination with Stakeholder and Volunteer Groups

Outreach to stakeholder and volunteer groups was conducted during VMP development, as summarized in Section 6. This Plan recommends continued and on-going coordination between OFD and local volunteer and stewardship groups that are active in parklands or other areas within the VMP. This VMP recognizes that effective communication and coordination is the responsibility of both the OFD and the local stewardship groups to each make an effort to keep the other party informed and updated.

The following communication protocols are recommended to help keep OFD and local stewardship efforts coordinated.

- OFD shall identify a point-of-contact for communication and coordination purposes with local park stewardship groups. The Vegetation Management Unit of the Fire Prevention

Bureau of OFD will be responsible for this outreach, and can be contacted at 510-238-7388 or wildfireprevention@oaklandca.gov. Similarly, each park stewardship group will identify a point-of-contact for coordination with OFD. OFD will maintain an updated list of the points-of-contact, including names, telephone numbers, and email addresses. If there is a change in status regarding the point-of-contact for either the OFD or the local stewardship groups, it is their responsibility to contact OFD to update the contact list.

- During the annual work plan development process, the OFD will reach out to the local park stewardship groups (though the point-of-contact) to solicit input or feedback on current vegetation management needs in the specific park, potential treatment options, treatment timing, local site conditions, and previous vegetation management efforts conducted on site. This coordination is especially important when a new contractor is selected to conduct vegetation management within a park. Coordination with the park stewardship group may include a site visit with OFD and/or the new vegetation management contractor.

- When the OFD has a clearer understanding of when vegetation management work will be performed in a specific park(s), they will provide this schedule update to the identified point-of-contact for that park(s).

- Similarly, volunteer/park stewardship groups must contact OFD prior to implementing vegetation management actions in the Plan Area. Key things for local stewards to update the OFD on include the location and extent of planned steward actions. This is an important step to minimize the potential for steward projects to potentially conflict with City plans or goals for vegetation management.

Volunteers and stakeholder groups that provided input during the VMP development process are identified in Appendix K. In addition to the identified stewardship groups in Appendix K, the Oakland Wildland Stewards (OWLS) is a coalition of stewardship groups operating in the Plan Area.

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12 PLAN IMPLEMENTATION

The following sections outline the methods for implementing the vegetation management recommendations included in this plan over the 10-year plan timeframe.

12.1 Roles and Responsibilities

OFD, or its designee, will be responsible for implementing this VMP and will be responsible for the following:

- Assessing field conditions on a routine basis to determine the need for vegetation management action implementation;
- Developing annual work plans and budgets;
- Prioritizing vegetation treatment actions and areas based on field observations;
- Screening, selecting, and hiring contractors, or directing City personnel, to conduct identified vegetation management actions;
- Monitoring vegetation management actions during operations to ensure that avoidance measures and BMPs are being properly implemented; and
- Monitoring treated properties following vegetation management actions to ensure that treatment standards have been achieved.

12.2 Planning and Scheduling

Planning and scheduling of vegetation management activities is anticipated to be an ongoing process conducted throughout most of the calendar year and based on the results of field assessments conducted by OFD staff. Most planning and scheduling efforts will be conducted in the winter or spring months for work to be conducted in the upcoming spring and summer months, although such efforts may occur at different times during the year, depending on the need for additional, increased, or follow-up vegetation management activities. Concurrent planning and scheduling of different vegetation management activities on different properties is also anticipated, as some activities (e.g., prescribed fire) may necessitate a longer planning and scheduling period than others. Planning and scheduling activities will also consider site treatment timing priorities and constraints, available resources, and efficient progression of treatment activities across properties. Planning and scheduling activities will include coordination with park stakeholder groups (discussed in Section 11.2), outreach to identified City departments, preparation of bid specifications and bid packages, contractor screening, selection, and hiring, and developing direction for City personnel, where applicable. Where feasible, OFD may engage other City departments and/or volunteer groups to perform some or all of the recommended vegetation treatments for a particular site. However, fire hazard reduction shall be the primary goal and OFD shall have the final say regarding vegetation management actions conducted in areas with volunteer/park stewardship group engagement. The intent is not to dismiss local volunteer knowledge and expertise, rather OFD has an obligation under this VMP to ensure that vegetation management is conducted in a timely manner and to standards that reduce wildfire hazard.

12.3 Monitoring and Reporting

OFD routinely patrols and monitors the Plan Area to inspect vegetation conditions and monitor the progress of treatment activities. Monitoring in the spring months is intended to inform the annual work plan development process. Monitoring not directly associated with annual work plan development should be routinely conducted for the following purposes:

- Monitoring vegetation management activities during operations to ensure that avoidance measures and BMPs (Section 10, Appendix I) are being properly implemented;
- Monitoring treated properties following vegetation management activities to ensure that treatment standards have been achieved;
- Monitoring treated properties to determine the need for follow-up treatment actions;
- Monitoring treated properties to determine the need for post-operations BMPs; and
- Monitoring to document the success of vegetation treatment activities and identify needs for adjustments to vegetation treatment activities or standards.

OFD shall prepare an annual report summarizing the results of monitoring efforts, quantifying the number of parcels inspected and acreage treated, documenting annual expenditures associated with VMP implementation, identifying any additional resource needs, and summarizing any pertinent issues identified and addressed during VMP implementation. Based on the results of monitoring efforts, the annual report shall identify any proposed future changes to vegetation treatment activities conducted in the Plan Area; however, any identified changes shall be consistent with the locations, techniques, and standards outlined in this VMP. The annual report shall be submitted to the Oakland City Council for review and comment

The annual report shall provide the following metrics and include a discussion of VMP implementation performance in meeting, or failing to meet, the stated goal:

1. Acreage treated vs. treatment acreage identified in annual work plan. Subdivide treated acreage into two categories: 1) meets treatment standard immediately following treatment;

2) partially meets treatment standard immediately following treatment. Goal: 90% of treated area meets standards following treatment.

2. Hours of annual pre-treatment site assessments performed by OFD. Goal: 1 hour of assessment time per 10 acres of treated area.

3. Hours of active treatment work inspections performed by OFD. Goal: 1 hour of assessment time per 1 acre of treated area.

4. Hours of post-treatment monitoring performed by OFD. Goal: 1 hour of monitoring time per 5 acres of treated area.

5. Budget expended on vegetation management and associated tasks. Goal: Expended funds within 10% of annual budget.

12.4 Adaptive Management

Adaptive management is an iterative process of implementation, monitoring, and adjustment of management actions based on monitoring results (McEachern et al. 2007). The critical component of the adaptive management process for this VMP is the monitoring effort described in the previous section. The results of monitoring efforts conducted in support of this VMP will be used to determine which vegetation management activities or techniques are effective or ineffective; if there is a need to change or modify treatment techniques, selecting among the techniques listed in this plan; if there is a need to adjust the timing, duration, or priority of vegetation treatments on a specific property or within the Plan Area; if additional avoidance/minimization measures or BMPs need to be employed; or if there needs to be changes to avoidance/minimization measures or BMPs to reduce potential adverse effects of vegetation management on sensitive biological resources, water resources, aesthetics, soils, and slope stability. Monitoring will also allow for consideration of other factors occurring outside the parameters of this VMP (e.g., creation of a fuel break by a neighboring property owner) that may have an effect on vegetation management planning or implementation.

OFD will document the results of monitoring efforts, as described in the previous section, noting recommended changes to vegetation management activities or actions associated with avoidance/minimization measures or BMPs. Plan implementation tracking in a GIS environment will allow for location-based assessments of work histories and treatment effectiveness and is recommended in this VMP. This documentation will then be used by OFD during subsequent planning and scheduling efforts with recommended changes incorporated into the annual work plan.

12.5 Implementation Costs

An evaluation of vegetation management and biological monitoring costs was conducted to assist in Plan implementation budgeting. Costs were evaluated based on management technique. Sources consulted to determine potential costs associated with vegetation management in the Bay Area included OFD, CAL FIRE, other land management agencies, private contractors, and biological consultants. In general, costs were variable, depending on the source due to variability in site access, vegetation density, and treatment prescriptions. Therefore, a range of costs was identified by management technique, as summarized in Table 13. These values were then used to determine potential VMP implementation and maintenance cost ranges for identified projects, as presented in Appendix H.

Table 13
Implementation and Maintenance Cost Estimates

Management Technique	Estimated Cost per Acre*	
	Low	High
Biological (Grazing) – Grass	$1,000	$1,200
Hand Labor – Grass	$1,000	$2,500
Hand Labor – Brush	$1,000	$4,000
Hand Labor – Forest	$2,500	$4,000
Mechanical – Grass	$75	$500
Mechanical – Brush	$2,000	$6,500
Mechanical – Forest	$3,000	$7,500
Mechanical – Prescribed Fire	$150	$5,000
Chemical – Herbicide Application	$250	$500
Biological Monitoring (Pre-Operations)	$60	$80

*Individual large tree removal costs can vary significantly depending on site conditions, with costs ranging from $200 to $2,000 per tree. Cost estimate based on 2019 data.

12.6 Priority Projects

Specific projects have been listed by park or region in Section 9.2. The projects in Table 14 are listed by their general priority (Priority 1, 2, and 3). The listing of the projects in each priority category is by their appearance in the document, and does not indicate an additional level of priority.

Table 14
Priority Project Summary Table

Location	Project	Description
Priority 1		
Urban Parcels	URB-1	Maintain vegetation within the entirety of all urban and residential parcels according to the standard outlined in Section 9.1. Treatment area equals 47.5 acres, accounting for non-vegetated areas within urban parcels.
Garber Park	GAR-1	Manage vegetation along adjacent roadside (Claremont Avenue) and near trailheads/entry points to minimize ignition potential. Treatment width should be based on field observations, but not to exceed 30 feet. Specifically, trees hanging down on powerlines are a fire hazard and should be prioritized for treatment. At a 30-foot width, the treatment area equals 1.3 acres.
	GAR-2	Manage vegetation within 10 feet of the south and east property boundary line to facilitate firefighter access according to the standards outlined in Section 9.1. Treatment area equals 0.5 acres.
Dimond Canyon Park	DIM-1	Manage vegetation along adjacent roadsides (Park Boulevard, Monterey Boulevard, Leimert Boulevard, El Centro Avenue) and near trailheads/entry points to minimize ignition potential. Treatment width should be based on field observations, but not to exceed 30 feet. At a 30-foot width, the treatment area equals 3.4 acres.
	DIM-2	Manage vegetation within 10 feet of property boundary lines where the park abuts residential structures to facilitate firefighter access according to the standards outlined in Section 9.1. Treatment area equals 2.5 acres.
	DIM-3	Manage vegetation in the area between the parking lot located to the east of the pool and the adjacent residential structures (approximately 50 feet in width). Treatment area equals 0.7 acres.
Shepherd Canyon Park	SHP-1	Manage vegetation within 100 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 13.2 acres.
	SHP-2	Manage vegetation along adjacent roadsides (Shepherd Canyon Road, Escher Drive, Snake Road, and Bagshotte Drive) to minimize ignition potential. Treatment width should be based on field observations, but not to exceed 30 feet. At a 30-foot width, the treatment area equals 9.3 acres.
Leon Heights Park	LHT-1	Manage vegetation within 100 feet of structures, within 300 feet of ridgelines, and within the current 9-acre management area according to the standards outlined in Section 9.1. Treatment area equals 13.6 acres.
	LHT-2	Manage vegetation along adjacent roadside (Campus Drive) to minimize ignition potential. Treatment width should be based on field observations, but not to exceed 30 feet. At a 30-foot width, the treatment area equals 1.9 acres.
Beaconsfield Canyon	BCN-1	Manage vegetation within 100 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 1.7 acres.
North Oakland Regional Sports Field	NOR-1	Manage vegetation according to the standards outlined in Section 9.1 in the following locations: within 30 feet of the site's dirt access road, within 300 feet of ridgelines, within 150 feet of the park access gate, and within the existing managed area north of the ball fields and parking areas. Treatment area equals 21.5 acres.
Grizzly Peak Open Space	GPO-1	Manage vegetation within 100 feet of structures, within 300 feet of ridgelines, and within 30 feet of Tunnel Road and Bay Forest Drive according to the standards outlined in Section 9.1. Treatment area equals 28.5 acres

Table 14
Priority Project Summary Table

Location	Project	Description
Sheffield Village Open Space	SHF-1	Manage vegetation within 100 feet of structures, including those in the Dunsmuir Estates portion of the property, and within 150 feet of park access gates, according to the standards outlined in Section 9.1. Treatment area equals 23.9 acres
Knowland Park and Arboretum	KNO-1	Manage vegetation within 100 feet of structures, within 150 feet of park access gates, and within 300 feet of ridgelines, which encompasses the area within 30 feet of known human congregation/activity areas along Skyline Boulevard according to the standards outlined in Section 9.1. Treatment area equals 28.4 acres.
	KNO-2	Manage vegetation along adjacent roadside (Golf Links Road). Treatment width should be based on field observations, but not to exceed 30 feet. At a 30-foot width, the treatment area equals 8.4 acres.
Joaquin Miller Park	JMP-1	Manage vegetation within 100 feet of on and off-site structures, within 300 feet of ridgelines, within 150 feet of park access gates and within 30 feet of known human congregation/activity areas along Skyline Boulevard and the top of Woodside Glen Court according to the standards outlined in Section 9.1. Treatment area equals 117.3 acres.
	JMP-2	Manage vegetation along adjacent roadsides (Joaquin Miller Road, Skyline Boulevard, Mountain Boulevard). Treatment width should be based on field observations, but not to exceed 30 feet. At a 30-foot width, the treatment area equals 18.2 acres.
King Estate Open Space Park	KES-1	Manage vegetation within 100 feet of structures, within 150 feet of park access gates, and within 30 feet of Fontaine Street and Crest Avenue according to the standards outlined in Section 9.1. Treatment area equals 15.6 acres.
Blue Rock Court	BLU-1	Manage vegetation within 100 feet of structures and within 30 feet of fire access road along southern property edge according to the standards outlined in Section 9.1. Treatment area equals 2.4 acres.
Leona Street	LST-1	Manage vegetation within 100 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 0.4 acres.
McDonell Avenue	MCD-1	Manage vegetation within 100 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 0.9 acres.
Police/Safety Department	PSD-1	Manage vegetation within 100 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 7.2 acres.
	PSD-2	Manage vegetation along adjacent roadside (Mountain Boulevard). Treatment width should be based on field observations, but not to exceed 30 feet. At a 30-foot width, the treatment area equals 0.5 acres.
Tunnel Road Open Space	TRO-1	Continue to manage vegetation via grazing throughout the property to minimize ignition potential from adjacent roadways. Treatment area equals 4.4 acres.
Marjorie Saunders Park	MJS-1	Manage vegetation within 100 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 0.9 acres
Oak Knoll	OKN-1	Manage vegetation within 100 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 1.2 acres.
Priority Roadsides and Medians	n/a	Priority roadsides (30 miles) and all medians (5.7 acres) are considered Priority 1 treatment areas (as defined in Section 9.3.3). The remaining roadside areas (278 miles) are considered Priority 2 treatment areas (as defined in Section 9.3.3). It is recommended that these areas and parcels continue to be managed according to the standards outlined in Section 9.1

Table 14
Priority Project Summary Table

Location	Project	Description
Priority 2		
Shepherd Canyon Park	SHP-3	Implement brush and tree thinning recommendations in areas exhibiting extreme fire behavior and within 300 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 11.8 acres.
Leona Heights Park	LHT-3	Implement brush and tree thinning recommendations in areas exhibiting extreme fire behavior and within 300 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 3.8 acres.
Beaconsfield Canyon	BCN-2	Implement brush and tree thinning recommendations in areas exhibiting extreme fire behavior and within 300 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 2.0 acres.
North Oakland Regional Sports Field	NOR-2	Given the upper portion of the property's ridgetop location and the potential for ember generation resulting from crown fire, implement thinning recommendations in the property's eucalyptus stand beyond that treated under project NOR-1 according to the standards outlined in Section 9.1. Treatment area equals 7.8 acres.
Grizzly Peak Open Space	GPO-2	Implement brush and tree thinning recommendations in areas exhibiting extreme fire behavior and within 300 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 19.1 acres.
Sheffield Village Open Space	SHF-2	Manage vegetation within 300 feet of structures in areas that exhibit extreme fire behavior according to the standards outlined in Section 9.1. Treatment area equals 6.1 acres.
Knowland Park and Arboretum	KNO-3	Manage vegetation within 300 feet of structures in areas that exhibit extreme fire behavior according to the standards outlined in Section 9.1. Treatment area equals 14.0 acres.
	KNO-4	Manage vegetation within 100 feet of on-site structures in the zoo portion of the property and within 100 feet of the zoo/open space interface to minimize ignition potential and modify potential fire behavior near this developed portion of the property. Treatment area equals 32.1 acres.
Joaquin Miller Park	JMP-3	Implement brush and tree thinning recommendations in areas exhibiting extreme fire behavior and within 300 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 13.8 acres.
Blue Rock Court	BLU-2	Implement brush and tree thinning recommendations in areas exhibiting extreme fire behavior and within 300 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 0.5 acres.
Marjorie Saunders Park	MJS-2	Implement brush and tree thinning recommendations in areas exhibiting extreme fire behavior and within 300 feet of structures according to the standards outlined in Section 9.1. Treatment area equals 1.8 acres.
Other Roadsides	n/a	Other roadside areas (278 miles) are considered Priority 2 treatment areas (as defined in Section 9.3.3). It is recommended that these areas and parcels continue to be managed according to the standards outlined in Section 9.1
Priority 3		
Garber Park	GAR-3	To manage fuel loading rates, remove eucalyptus trees from two locations along the southern park boundary, retaining non-pyrophytic trees. Treatment area equals 0.7 acres.

Table 14
Priority Project Summary Table

Location	Project	Description
Shepherd Canyon Park	SHP-4	Continue to manage vegetation via grazing throughout the remainder of the park to maintain fuel loads. If possible, grazing should be conducted later in the season after perennial grasses go to seed. Treatment area equals 20.4 acres
North Oakland Regional Sports Field	NOR-3	To reduce fuel loading rates, remove eucalyptus trees and other highly flammable and invasive plants from oak woodland communities, retaining non-pyrophytic trees. Treatment area equals 18.6 acres.
Grizzly Peak Open Space	GPO-3	To reduce fuel loading rates, remove eucalyptus trees and other highly flammable and invasive plants from oak woodlands, retaining non-pyrophytic trees. Treatment area equals 1.6 acres.
	GPO-4	Continue to manage vegetation via grazing throughout the remainder of the property to maintain fuel loads. Treatment area equals 19.9 acres.
Sheffield Village Open Space	SHF-3	Continue to manage vegetation via grazing throughout the remainder of the park to maintain fuel loads. Treatment area equals 288.3 acres.
Knowland Park and Arboretum	KNO-5	Continue to manage vegetation via grazing throughout the remainder of the park to maintain fuel loads. Treatment area equals 368.1 acres
Joaquin Miller Park	JMP-4	Continue to manage vegetation via grazing in flashy fuel areas to maintain fuel loads. Treatment area equals 68.3 acres.
King Estate Open Space Park	KES-2	Continue to manage vegetation via grazing throughout the remainder of the park to maintain fuel loads and minimize ignition potential, particularly prior to the 4th of July holiday. Treatment area equals 65.6 acres.
Blue Rock Court	BLU-3	Implement thinning recommendations in the property's eucalyptus stand beyond that treated under project BLU-2 according to the standards outlined in Section 9.1. Treatment area equals 6.4 acres.
Oak Knoll	OKN-2	Continue to manage vegetation via grazing throughout the remainder of the park to maintain fuel loads and minimize ignition potential. Treatment area equals 14.5 acres.

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This document was also reviewed by environmental scientists at Horizon Water and Environment (Ken Schwarz and Robin Hunter) and fire professionals and managers at the City of Oakland.

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APPENDIX A

Glossary of Terms

APPENDIX A
Glossary of Terms

BehavePlus: Fire behavior prediction and fuel modeling computer program designed to model fire behavior characteristics based on fuel, weather, and topographic inputs. Model outputs include flame length values, fire spotting potential, and rate of fire spread.

Brush: A collective term that refers to stands of vegetation dominated by shrubby, woody plants or low-growing trees; usually of a vegetation type undesirable for livestock or timber management.

Brush Fire: A fire burning in vegetation that is predominantly shrubs, brush, and scrub growth.

Burning Conditions: The state of the combined factors of the environment that affect fire behavior in a specified fuel type.

Canopy: The stratum containing the crowns of the tallest vegetation present (living or dead), usually above 20 feet.

Closure: Legal restriction, but not necessarily elimination, of specified activities such as smoking, camping, or entry that might cause fires in a given area.

Combustible: Any material that, in the form in which it is used and under the conditions anticipated, will ignite and burn.

Conflagration: A raging, destructive fire. Often used to describe a fire burning under extreme fire weather. The term is also used when a wildland fire burns into a WUI, destroying structures.

Crown Fire: A fire that advances from top-to-top of trees or shrubs more or less independent of a surface fire.

Defensible Space: An area either natural or man-made where material capable of allowing a fire to spread unchecked has been treated, cleared, or modified to slow the rate and intensity of advancing wildfire. This will create an area for housing increased emergency fire equipment, for evacuating or sheltering civilians in place, and a point for fire suppression to occur.

Duff: The layer of decomposing organic materials lying below the litter layer of freshly fallen twigs, needles and leaves and immediately above the mineral soil.

Exposure: (1) Property that may be endangered by a fire burning in another structure or by a wildfire; (2) direction in which a slope faces, usually with respect to cardinal directions; (3) the general surroundings of a site with special reference to its openness to winds.

Extreme Fire: A level of fire behavior characteristics that ordinarily precludes methods of direct control. One or more of the following is usually involved: high rates of spread, prolific crowning and/or spotting, presence of fire whirls, a strong convection column. Predictability is difficult because such fires often exercise some degree of influence on their environments and behave erratically, sometimes dangerously.

Fine Fuels: Fast-drying dead fuels that are less than 0.25-inch in diameter and are generally characterized by a comparatively high surface area to volume ratio. These fuels (grass, leaves, needles, etc.) ignite readily and are consumed rapidly by fire when dry.

Fire Behavior: The manner in which a fire reacts to the influences of fuel, weather, and topography.

Fire Department: Any regularly organized fire department, fire protection district or fire company regularly charged with the responsibility of providing fire protection to the jurisdiction.

Fire Front: That part of a fire within which continuous flaming combustion is taking place. Unless otherwise specified, it is assumed to be the leading edge of the fire perimeter.

Fire Hazard: A fuel complex, defined by volume, type condition, arrangement, and location, that determines the degree of ease of ignition and of resistance to control.

Fire Hydrant: A valved connection on a piped water supply system having one or more outlets that is used to supply hose and fire department pumpers with water.

Fire Prevention: Activities, including education, engineering, enforcement, and administration that are directed at reducing the number of wildfires, the costs of suppression, and fire-caused damage to resources and property.

Fire Protection: The actions taken to limit the adverse environmental, social, political, and economic effects of fire. Protection is relative, not absolute.

Fire Regime*:* Periodicity and pattern of naturally occurring fires in a particular area or vegetative type, described in terms of frequency, biological severity, and area of extent.

Fire Retardant: Any substance, except plain water, that by chemical or physical action reduces flammability of fuels or slows their rate of combustion.

Fire Season: (1) Period(s) of the year during which wildland fires are likely to occur, spread, and affect resource values sufficient to warrant organized fire management activities; (2) a legally enacted time during which burning activities are regulated by state or local authority.

Fire Storm: Violent convection caused by a large continuous area of intense fire. Often characterized by destructively violent surface indrafts, near and beyond the perimeter, and sometimes by tornado-like whirls.

Fire Triangle: Instructional aid in which the sides of a triangle are used to represent the three factors (oxygen, heat, fuel) necessary for combustion and flame production; removal of any of the three factors causes flame production to cease.

Fire Weather: Weather conditions which influence fire starts, fire behavior, or fire suppression.

Fire Whirl: Spinning vortex column of ascending hot air and gases rising from a fire and carrying aloft smoke, debris, and flame. Fire whirls range in size from less than 1 foot to over 500 feet in diameter. Large fire whirls have the intensity of a small tornado.

Firebrand: Any source of heat, natural or human made, capable of igniting wildland fuels. Flaming or glowing fuel particles that can be carried naturally by wind, convection currents, or gravity into unburned fuels. Examples include leaves, pine cones, glowing charcoal, and sparks.

Firebreak: A natural or constructed barrier used to stop or check fires that may occur or to provide a control line from which to work.

Firefighter: A person who is trained and proficient in the components of structural or wildland fire.

Flame: A mass of gas undergoing rapid combustion, generally accompanied by evolution of sensible heat and incandescence.

Flammability: The relative ease with which fuels ignite and burn regardless of the quantity of the fuels.

Fuel Break: An area, strategically located for fighting anticipated fires, where the previously-occurring vegetation has been permanently modified or replaced so that fires burning into it can be more easily controlled. Fuel breaks divide fire-prone areas into smaller areas for easier fire control and to provide access for firefighting.

Fuel Loading: The volume of fuel in a given area generally expressed in tons per acre.

Fuel Model: Simulated fuel complex for which all fuel descriptors required for the solution of a mathematical rate of spread model have been specified.

Fuel Modification: Any manipulation or removal of fuels to reduce the likelihood of ignition or the resistance to fire control.

Fuel Modification Zone: A strip of land, typically 100 feet wide or more, between an improved property and wildlands, where combustible vegetation has been removed, thinned, or modified and may be partially or totally replaced with approved drought-tolerant, fire-resistant, and/or irrigated plants to provide an acceptable level of risk from vegetation fires. Fuel modification reduces radiant and convective heat, thereby reducing the amount of heat exposure on the roadway or structure and providing fire suppression forces a safer area in which to take action.

Fuels: All combustible material within the WUI or intermix, including vegetation and structures.

Hazard: The degree of flammability of the fuels once a fire starts. This includes the fuel (type, arrangement, volume, and condition), topography, and weather.

High Value Resource: High Value Resources are natural or man-made resources, including plant and animal species, cultural resources, and residences that form the basis for fire management planning on the Property.

Ignition Time: Time between application of an ignition source and self-sustained combustion of fuel.

Invasive Plant Species: A plant species that is not native to the region and has demonstrated the ability to aggressively outcompete native plant species that would normally colonize a given area.

Ladder Fuels: Fuels that provide vertical continuity allowing fire to carry from surface fuels into the crowns of trees or shrubs with relative ease.

Overstory: That portion of the trees in a forest that forms the upper or uppermost layer.

Peak Fire Season: That period of the year during which fires are expected to ignite most readily, to burn with greater than average intensity, and to create damages at an unacceptable level.

Prescribed Burning: Controlled application of fire to wildland fuels in either their natural or modified state, under specified environmental conditions, which allows the fire to be confined to a predetermined area, and to produce the fire behavior and fire characteristics required to attain planned fire treatment and resource management objectives.

Prescribed Fire: A fire burning within prescription. This fire may result from either planned or unplanned ignitions.

Project VESTA (ENSIS October 2007): Southern Australia's most recent and significant study of eucalyptus forest fire behavior. The project was designed to provide new fuel models to estimate the fuel characteristics of different fuel types and identified better fuel parameters to predict the behavior of fire in dry eucalypt forest.

Protected Species: State- and federally-listed Endangered or Threatened species of flora or fauna, and non-listed species otherwise protected by state and/or federal statutes.

Red Flag Warning Conditions: A **Red Flag Warning** is a forecast warning issued by the United States National Weather Service to inform area firefighting and land management agencies that conditions are ideal for wildland fire ignition and propagation. After drought conditions, and when humidity is very low, and especially when high or erratic winds that may include lightning are a factor, the Red Flag Warning becomes a critical statement for firefighting agencies, which often alter their staffing and equipment resources dramatically to accommodate the forecast risk.

Responsibility Area: That area for which a particular fire protection organization has the primary responsibility for attacking an uncontrolled fire and for directing the suppression action. Such responsibility may develop through law, contract, or personal interest of the fire protection agent. Several agencies or entities may have some basic responsibilities without being known as the fire organization having direct protection responsibility.

Sensitive Species: A plant or animal species with a special status listing from federal, state, or local regulatory agencies.

Slope: The variation of terrain from the horizontal; the number of feet rise or fall per 100 feet measured horizontally, expressed as a percentage.

Smoke: (1) The visible products of combustion rising above a fire; (2) term used when reporting a fire or probable fire in its initial stages.

Spotting: The ignition of unburned fuels ahead of the fire front as a result of ignition by firebrands. Spotting enhances the spread of wildfires.

Structure: A habitable structure (as defined by Oakland City Code), historic structure, or other City owned or maintained building (e.g., park maintenance building) or attachment thereto.

Structure Fire: Fire originating in and burning any part of all of any building, shelter, or other structure.

Suppression: The most aggressive fire protection strategy, it leads to the total extinguishment of a fire.

Surface Fuel: Fuels lying on or near the surface of the ground, consisting of leaf and needle litter, dead branch material, downed logs, bark, tree cones, and low stature living plants.

Tree Crown: The primary and secondary branches growing out from the main stem, together with twigs and foliage.

Uncontrolled Fire: Any fire that threatens to destroy life, property, or natural resources and that (a) is not burning within the confines of firebreaks or (b) is burning with such intensity that it could not be readily extinguished with ordinary, commonly available tools.

Understory: Low-growing vegetation (herbaceous, brush or reproduction) growing under a stand of trees. Also, that portion of trees in a forest stand below the overstory.

Urban Interface: Any area where wildland fuels threaten to ignite combustible homes and structures.

Vegetation Management Unit: Delineated Property unit based on topography, vegetation or other features used for internal invasive species, restoration, and fire management planning.

Weed: A plant species that interferes with a desired management objective. This term does not denote the native or non-native status of a plant species. Both native and non-native plants have the ability to interfere, depending on the objective (i.e., native cattails can be considered a weed for flood control management objectives).

Wildfire: An unplanned and uncontrolled fire spreading through vegetative fuels, at times involving structures.

Wildland: An area in which development is essentially nonexistent, except for roads, railroads, power lines, and similar transportation facilities. Structures, if any, are widely scattered.

Wildland Fire: Any fire occurring on the wildlands, regardless of ignition source, damages or benefits.

Wildland–Urban Interface (WUI): The area where structures and other human developments meet or intermingle with undeveloped wildland (as defined in the County Fire Code, County Consolidated Fire Code, and County Building Code).

Source: www.firewise.org

APPENDIX B

Biological Resources Report

Revised Biological Resources Report
Oakland Vegetation Management Plan

Prepared for: City of Oakland
1 Frank Ogawa Plaza
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Prepared by: Horizon Water and Environment
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August 2019

Horizon Water and Environment. *Oakland Vegetation Management Plan. Revised Biological Resources Report*. August 2019. (HWE 16.042) Oakland, CA.

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1.0 Introduction

Oakland, California, contains topographic, vegetation, and climatic conditions which combine to create a unique situation capable of supporting large-scale, high-intensity, and sometimes damaging wildfires, such as the 1991 Tunnel Fire. As part of a broader, multi-faceted approach to fire hazard reduction, the City of Oakland (City) is developing a Vegetation Management Plan (Plan) to reduce the risk of catastrophic fire in the Very High Fire Hazard Severity Zone (VHFHSZ). Specifically, the Plan Area includes:

- 434 City-owned parcels, ranging in size from >0.1 to 235 acres and totaling 1,948 acres
- Roadside areas along 308 miles of road within the City's VHFHSZ, which includes surface and arterial streets, State Routes 13 and 24, and Interstate 580

An overview of the Plan Area is shown in **Figure 1**, and in more detail in **Figure 2**, Sheets 1-5.

1.1 Objectives of the Report

This purpose of this Biological Resources Report is to document current (existing) biological conditions within the Plan Area at the time of Plan development. This report includes mapping of vegetation and land cover, and identification of potential habitat for special-status species and sensitive natural communities. The findings of this report provide a baseline understanding of existing biological resources in the Plan Area. This report provides a foundation upon which the Plan will be developed to identify and describe vegetation management approaches to reduce fire risk.

2.0 Methods

Developing this report involved several steps including first collecting and reviewing pertinent reference materials, then conducting a series of field surveys of sites in the Plan Area, classifying and mapping vegetation and habitat conditions, and documenting these findings in this report. Vegetation types consist of assemblages of plant species that coexist in an area. These assemblages are influenced by climate, geology, soil, and disturbance, among other factors. Habitat is the natural setting under which organisms normally live, and is defined by both biotic and abiotic features. Broadly, the Plan Area includes both terrestrial and aquatic habitats, which are further divided and defined in Section 3.0.

2.1 Background Data Review

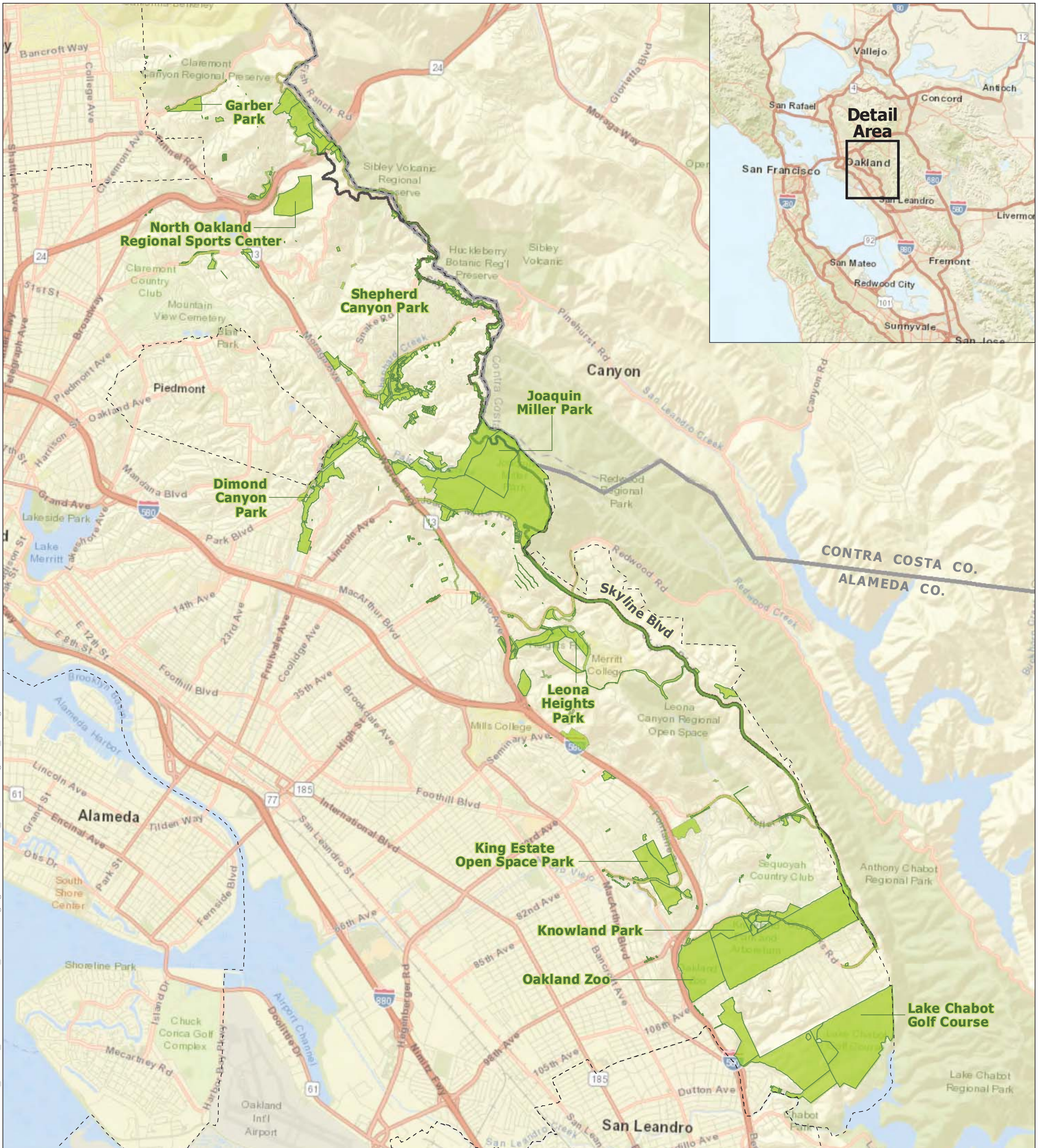
Biologists from Horizon Water and Environment (Horizon) collected and reviewed the following materials relevant to biological resources in the Plan Area.

- U.S. Fish and Wildlife Service (USFWS) Information for Planning and Conservation (IPaC) Report (USFWS 2017, Appendix A).
- California Natural Diversity Database (CNDDB) (CDFW 2017) and California Native Plant Society's (CNPS) Inventory of Rare and Endangered Plants of California (CNPS 2017) queries for the following USGS 7.5 minute quadrangles: Briones Valley,

Hayward, Hunters Point, Las Trampas Ridge, Oakland East, Oakland West, Richmond, San Leandro, and Walnut Creek (Appendix A).

- CNPS East Bay Chapter Rare, Unusual and Significant Plants of Alameda and Contra Costa Counties Database.
- Final Hazardous Fire Risk Reduction Environmental Impact Statement (EIS), (Federal Emergency Management Agency [FEMA] 2014).
- eBird.org records for the Plan Area (eBird 2017).
- East Bay Regional Park District (EBRPD) Draft Wildfire Hazard Reduction and Resource Management Plan (LSA 2009a) and EIR (LSA 2009b)
- Final Sausal Creek Watershed Enhancement Plan (Laurel Marcus and Associates et al. 2010).
- Vegetation Management Implementation Plan: Chabot Space and Science Center (WRA 2013).
- East Bay Watershed Master Plan Update (EBMUD 2016).
- URS Strawberry Canyon Vegetation Mitigation letter (URS 2009).

Figure 1. Plan Location



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Basebap Sources: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

Figure 1
Project Area

N

0 1 2
Miles

Project Area (Parcels and Roadside Treatment Areas)
City Limits
County Line

Sources: City of Oakland; County of Alameda

Horizon WATER and ENVIRONMENT

City of Oakland
Vegetation Managemant Plan
Biological Resources Report

2.2 Field Surveys

Field surveys to map land cover and vegetation and to identify potentially suitable habitat for special-status species within the Plan Area were conducted over several weeks in early 2017, including: on January 25, February 6, February 23, March 7, March 11, March 16, March 28, and April 27. Horizon Water and Environment's Oakland based ecologist/botanist, Robin Hunter, participated in all surveys. Oakland based wildlife biologist Brian Piontek, participated in the March 7 and 28, 2017 surveys. The biologists visited portions of the Plan Area with potentially sensitive biological resources on foot. Some portions of the Plan Area were observed with binoculars. Some parcels which were completely developed were mapped using aerial imagery. Portions of some parcels were mapped using vegetation signatures from aerial imagery. Wildlife species observed or recognized by signs such as scat, tracks, burrows, nests, bird songs, or calls during the survey were identified and recorded. An inventory of plant and wildlife species observed during the 2017 field surveys is provided in Appendix B.

2.3 Habitat Classification and Mapping

Habitats were mapped using the California Wildlife Habitat Relationships (CWHR) System (Mayer Laudenslayer 1988). This classification system was chosen because it is specifically appropriate for California landscapes such as the Oakland Hills, its relevance to wildlife, its accessibility to the public, the fact that it can be input into predictive fire models that will be used for the Vegetation Management Plan, and the flexibility of using this classification for habitat types over the large survey area. The minimum mapping unit was 0.1 acre, except in the instance of linear features, such as roads. Habitat classification types were entered into ArcGIS 10.3 software to create a vegetation and land cover layer covering the entire Plan Area, based on field survey data and interpretation of aerial imagery. Riverine habitat was mapped using data from the National Hydrography Dataset (USGS 2016). A crosswalk to other vegetation classification systems (e.g., Sawyer et. al 2009, CalVeg) is provided in Appendix C. Additionally, plants are designated as invasive if they are rated by the California Invasive Plant Council (Cal-IPC) as moderate or high (Cal-IPC 2006).

3.0 Habitats in the Plan Area

There is substantial variation in topography and land use within the Plan Area. Most of the Plan Area is situated in the hills of eastern Oakland, California. A smaller portion of the Plan Area is located on parcels within urban/residential areas in the vicinity of Highway 13 and I-580. Land uses include residential, transportation corridors, open space and park lands, and vacant lots Elevations in the Plan Area range from 100 feet above mean sea level (msl) at an urban parcel on Golf Links Road to approximately 1,540 feet above msl at the top of the ridgeline, near Chabot Science Center.

Prior to urbanization, vegetation in the Plan Area was primarily grasslands and shrublands, (Nowak 1993). Only about 2.3 percent of land in Oakland was covered by forests, including coast redwood (*Sequoia sempervirens*) forests, coast live oak (*Quercus agrifolia*) stands, and riparian woodlands (Nowak 1993). Major logging of redwood forests occurred in the mid-1800s (Simon 2014). Between 1880 and 1920 large scale tree planting occurred in the Oakland hills, initially by Joaquin Miller and later by Frank Havens (Nowak 1993). Tree species planted included pines (*Pinus* spp.), acacia (*Acacia* spp.), and eucalyptus (*Eucalyptus* spp.) (Nowak 1993). Frank Havens planted an estimated 3 million blue gum eucalyptus (*Eucalyptus globulus*) and Monterey pine (*Pinus radiata*) seedlings (Simon 2014).

Fire and vegetated fire hazard management have also shaped vegetation in the Oakland hills. In the last 100 years, 14 significant fires have occurred in the Oakland Hills (City of Oakland 2017). This includes the 1991 Tunnel Fire, which burned 1,700 acres (City of Oakland 2017). Many of the fires burned large areas, restarting succession of vegetation in these areas. Additionally, the City has conducted vegetated fire hazard management activities within the Plan Area since 2003. Activities such as goat grazing, brush and French broom removal, mowing, hand removal of weeds, tree trimming, removal of sapling eucalyptus and Monterey pine trees, removal of dead or dying vegetation, among other vegetation management practices have shaped vegetation in the Oakland hills by removing biomass, and in some cases shifting successional processes.

The following section provides descriptions of habitats present within the Plan Area. Terrestrial habitats are generally described in terms of vegetation present in these habitats. Figure 2 shows the mapped habitats within the Plan Area, and Table 1 summarizes habitat area and percent of the total Plan Area. Each community type is described based both on the habitat descriptions in the CWHR System and specific conditions encountered within the survey area. Section 4 describes the distribution of biological communities across different parcel types. Wildlife typically associated with these biological communities is also described below. Much of the information regarding typical wildlife associated with each habitat type is referenced from the EBRPD Draft Wildfire Hazard Reduction and Resource Management Plan EIR(LSA 2009b).

Table 1. Habitats and Spatial Coverage within the Plan Area

Vegetative Habitat Type	Acres	Percentage
Urban	654.6	29.2%
Coast Oak Woodland	630.6	28.1%
Annual Grassland	258.1	11.5%
Closed-cone Pine-Cypress	180.7	8.1%
Eucalyptus	177.9	7.9%
Coastal Scrub	176.9	7.9%
Redwood	141.4	6.3%
Perennial Grassland (Native Perennial Grassland)	13.4	0.6%
Mixed Chaparral (Maritime Chaparral)	8.1	0.4%
Valley/foothill Riparian	1.4	0.1%
Freshwater Emergent Wetland	0.4	<0.1%
Total	***2253***	***100.0%***

3.1 Terrestrial Habitats

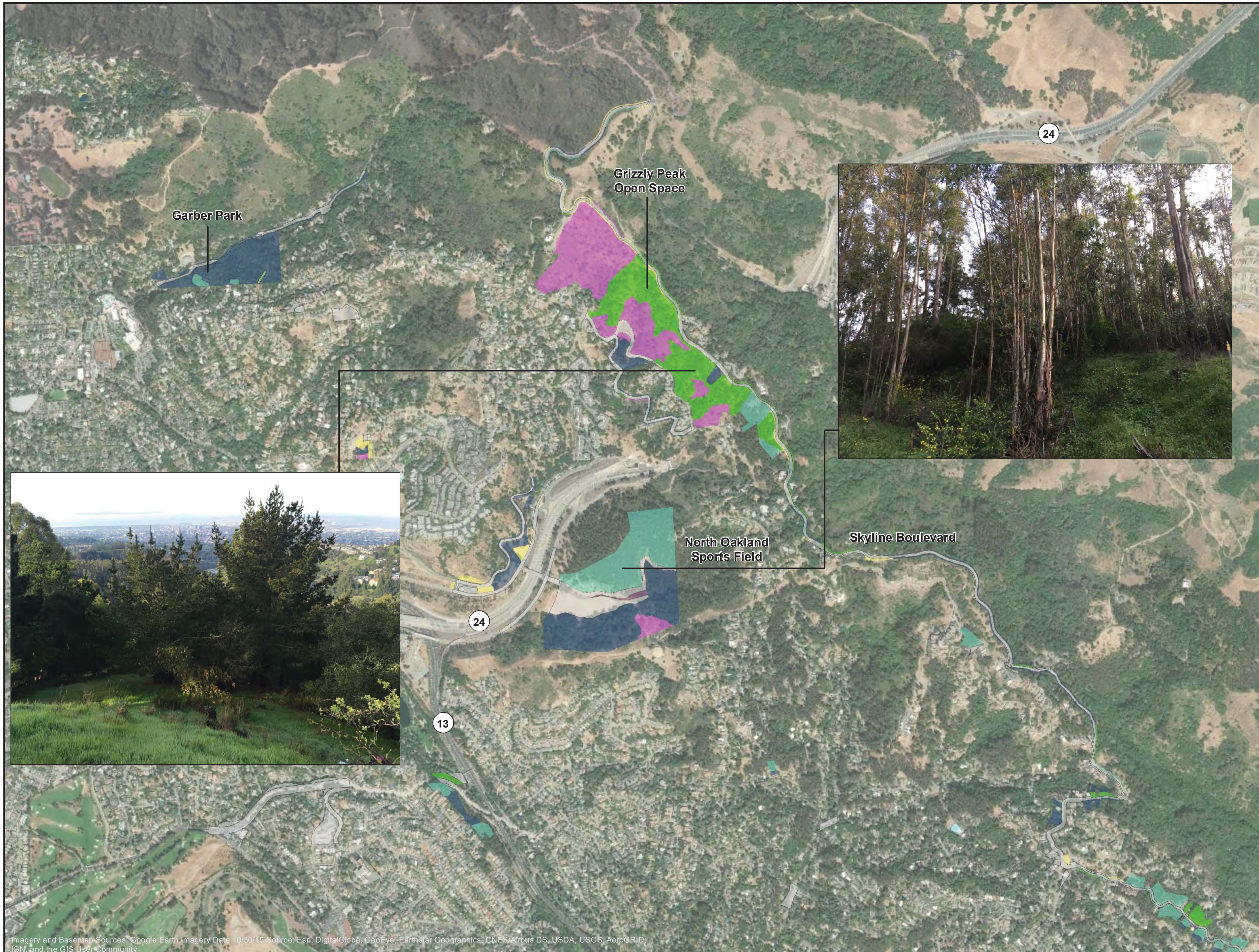
3.1.1 Tree-dominated

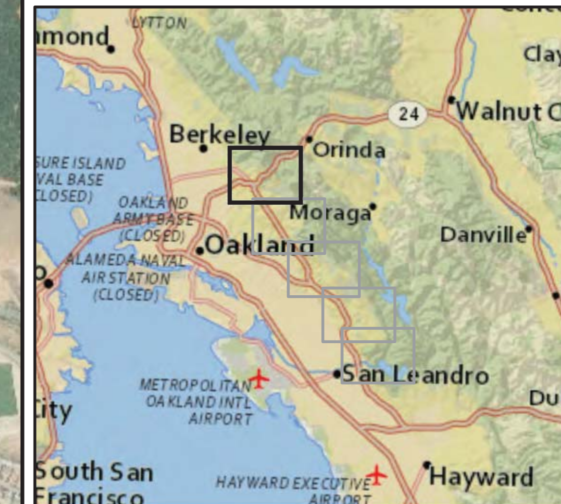
Coast Oak Woodland

This habitat is dominated by coast live oak; the canopy may range from open to relatively closed. This habitat is generally found along drainages within the Plan Area, but is also found along hillslopes and upland flats. In areas along drainages, California bay laurel (*Umbellularia californica*) is common, and may be co-dominant with coast live oak. California buckeye (*Aesculus californica*) is occasionally found in this habitat type. The understory is variable in composition and includes species such as native California blackberry (*Rubus ursinus*), poison oak (*Toxicodendron diversilobum*), oso berry (*Oemleria cerasiformis*), ocean spray (*Holodiscus discolor*), woodfern (*Dryopteris arguta*) and swordfern (*Polystichum munitum*), as well as non-native Himalayan blackberry (*R. armeniacus*). Forests dominated by coast live oak are considered to be one of the most fire resistant tree-dominated habitats (Sugihara et al. 2006). The thick bark and small leaves of coast live oak contribute to the fire resistance of this habitat (Sugihara et al. 2006).

On hill slopes and other non-riparian areas, coast live oaks are generally the main canopy species, and may be more widely spaced. In these locations, various grasses are often dominant in the understory, including wild oats (*Avena* spp.) and ripgut brome (*Bromus diandrus*). Purple needlegrass (*Stipa pulchra [=Nasella pulchra]*) is occasionally found in the understory in coast oak woodlands with a more open canopy.

Coast oak woodland support a diverse assemblage of wildlife. Amphibians associated with this habitat include ensatina (*Ensatina eschscholtzii*), arboreal salamander (*Aneides lugubris*), and California slender salamander (*Batrachoseps attenuatus*) (LSA 2009). Typical bird species include Nuttall's Woodpecker (*Picoides nuttallii*), Acorn Woodpecker (*Melanerpes formicivorus*), Western Scrub-Jay (*Aphelocoma californica*), Steller's Jay (*Cyanocitta stelleri*), Hutton's Vireo (*Vireo huttoni*), Oak Titmouse (*Baeolophus inornatus*), Violet-green Swallow (*Tachycineta thalassina*), Orange-Crowned Warbler (*Vermivora celata*), Bushtits (P*saltriparus minimus*), and Dark-Eyed Junco (*Junco hyemalis*). Raptors, including Red-Shouldered Hawk (*Buteo lineatus*) and Cooper's Hawk (*Accipiter cooperii*) may also occur. Amphibians such as California newt (*Taricha torosa*) may be found in this habitat, particularly near streams. Small mammals common to oak woodlands include California mouse (*Peromyscus californicus*), dusky-footed woodrat (*Neotoma fuscipes)*, as well as non-native eastern fox squirrel (*Sciurus niger*) (LSA 2009). Larger mammals typically found in this habitat include bobcat (*Lynx rufus*), coyote (*Canis latrans*), and California mule deer (*Odocoileus hemionus californicus*).





Habitat Types

- Annual Grassland
- Coast Oak Woodland
- Closed-cone Pine-Cypress
- Coastal Scrub
- Eucalyptus
- Freshwater Emergent Wetland
- Urban
- Valley/foothill Riparian

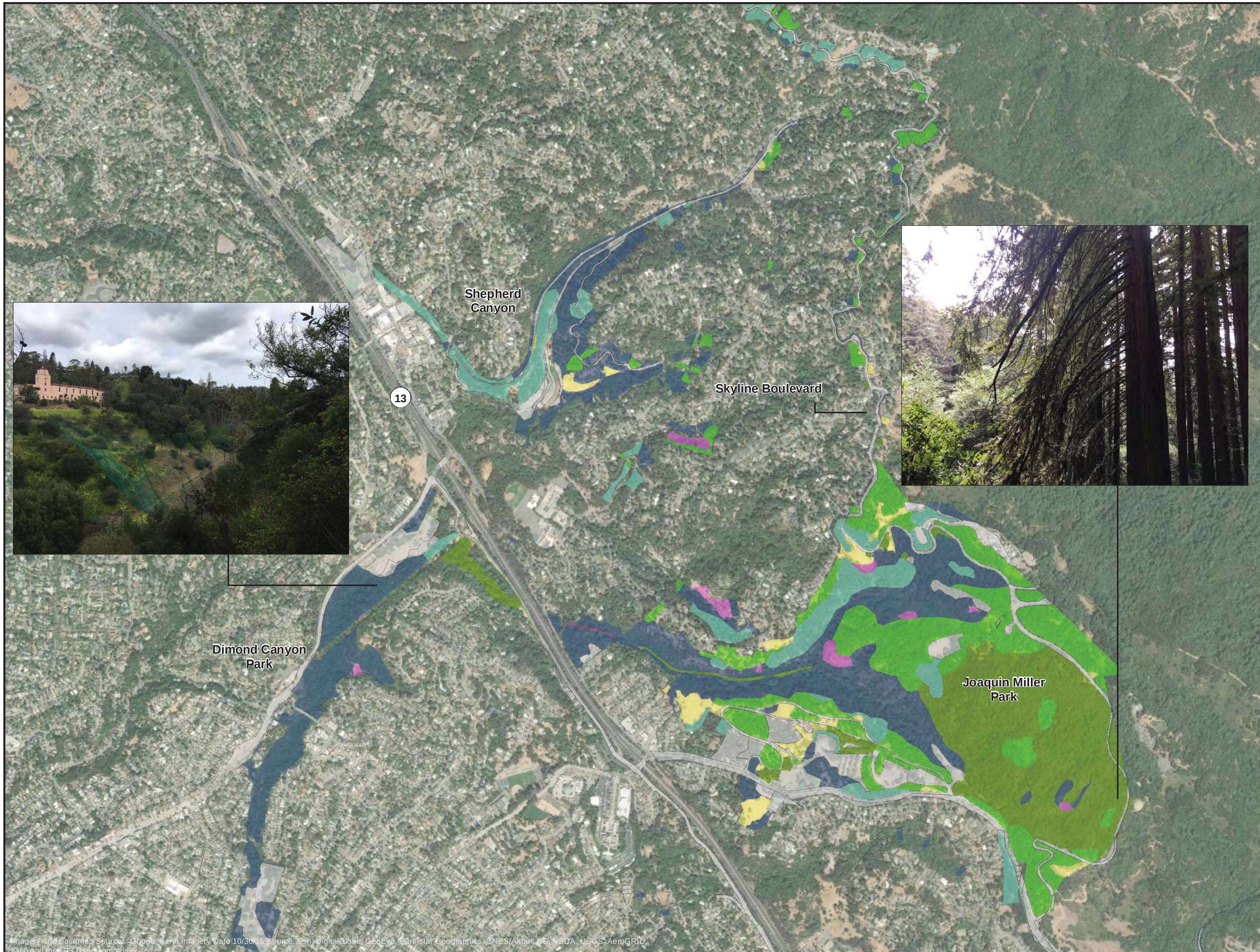
N

0 0.25 0.5
Miles

Figure 2
Sheet 1 of 5

Habitats in the Project Area

Oakland Vegetation Managment
Biological Resources Report



Habitat Types

- Annual Grassland
- Coast Oak Woodland
- Closed-cone Pine-Cypress
- Coastal Scrub
- Eucalyptus
- Freshwater Emergent Wetland
- Redwood
- Urban
- Valley/foothill Riparian

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Miles

Figure 2
Sheet 2 of 5

Habitats in the Project Area

Oakland Vegetation Managment
Biological Resources Report

Habitat Types

- Annual Grassland
- Coast Oak Woodland
- Closed-cone Pine-Cypress
- Coastal Scrub
- Eucalyptus
- Redwood
- Urban

N

0 0.25 0.5
Miles

Figure 2
Sheet 3 of 5

Habitats in the Project Area

Oakland Vegetation Managment
Biological Resources Report

Habitat Types

- Annual Grassland
- Coast Oak Woodland
- Closed-cone Pine-Cypress
- Coastal Scrub
- Eucalyptus
- Freshwater Emergent Wetland
- Mixed Chaparral
- Perennial Grassland
- Redwood
- Urban

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Miles

Figure 2
Sheet 4 of 5

Habitats in the Project Area

Oakland Vegetation Managment
Biological Resources Report

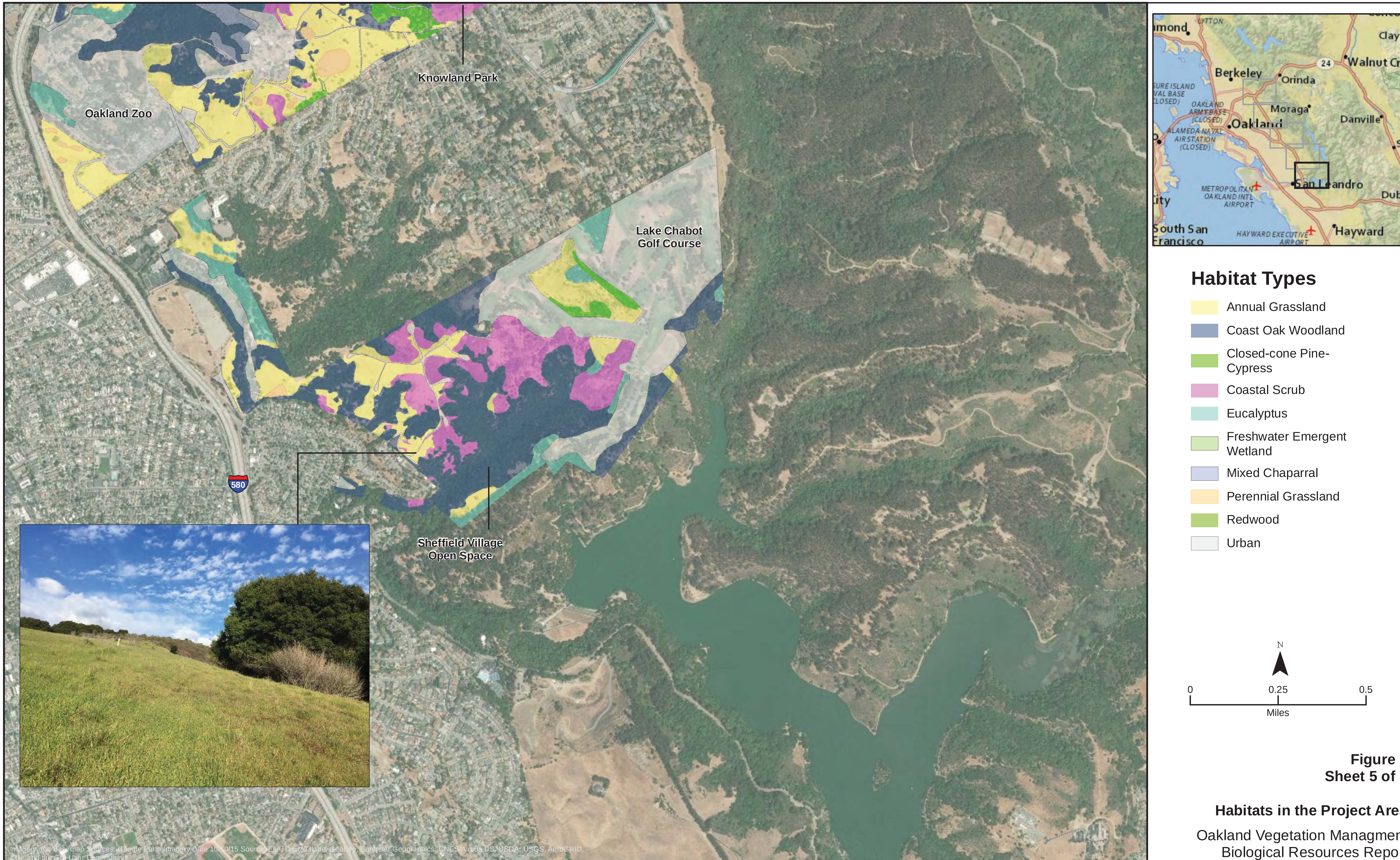


Figure 2
Sheet 5 of 5

Habitats in the Project Area

Oakland Vegetation Managment
Biological Resources Report

APPENDIX C

Fire Behavior Analysis

APPENDIX C
Fire Behavior Analysis

FLAMMAP FIRE BEHAVIOR MODELING

The FlamMap software package (Finney et al. 2015) was used to evaluate fire behavior in order to inform the prioritization of vegetation management recommendations included in this Vegetation Management Plan (VMP). FlamMap utilizes the same fire spread equations built into the BehavePlus software package, but allows for a geographical presentation of fire behavior outputs as it applies the calculations to each pixel in an associated geographic information system (GIS) landscape (Finney 1998). The FlamMap software package is a publicly available resource available through the Fire, Fuel, and Smoke Science Program of the U.S. Forest Service. FlamMap is a GIS-based software package that models potential fire behavior for constant weather conditions (wind and fuel moisture) and generates map files of potential fire behavior characteristics (e.g., flame length, crown fire activity). FlamMap outputs represent fire behavior calculated for each pixel within the analysis area independently and do not calculate fire spread across a landscape. The software requires a minimum of five input variables, including elevation, slope, aspect, fuel model, and canopy cover. To utilize the crown fire activity model for forested land cover types, additional input variables are necessary, including stand height, canopy base height, and canopy bulk density. Wind and weather data are also critical components to FlamMap modeling efforts. The following sections present a background on fire behavior modeling and present the methods and data sources used in performing the FlamMap fire behavior modeling analysis for the Plan Area.

FIRE BEHAVIOR MODELING BACKGROUND

Predicting wildland fire behavior is not an exact science due to the many variables that must be considered. As such, the movement of a fire will likely never be fully predictable, especially considering the variations in weather, the limits of weather forecasting, and the weather that is often created by firestorms. Nevertheless, practiced and experienced judgment, coupled with a validated fire behavior modeling system, results in useful and accurate fire information (Rothermel 1993). To be used effectively, the basic assumptions and limitations of fire behavior modeling applications must be understood.

- First, it must be realized that the fire model describes fire behavior only in the flaming front. The primary driving force in the predictive calculations is dead fuel less than 0.25 inches in diameter. These are the fine fuels that carry fire. Fuels greater than 1 inch in diameter have little effect, while fuels greater than 3 inches in diameter have no effect on fire behavior.
- Second, the model bases surface fire calculations and descriptions on a wildfire spreading through fuels that are within 6 feet of the ground and contiguous to the ground. Surface fuels are classified as grass, grass/shrub, shrub, timber litter, timber understory, or slash.

- Third, the software assumes that weather is uniform. However, because wildfires almost always burn under non-uniform conditions, creating their own weather, length of projection period and choice of fuel model must be carefully considered to obtain useful predictions.
- Fourth, fire behavior computer modeling systems are not intended for determining sufficient fuel modification zone/defensible space widths. However, results can provide the average length of the flames, which is a key element for determining defensible space distances for minimizing structure ignition.

FlamMap can provide valuable fire behavior predictions, which can be used as a tool in the decision-making process. In order to make reliable estimates of fire behavior, one must understand the relationship of fuels to the fire environment and be able to recognize the variations in these fuels. Fuels are made up of the various components of vegetation, both live and dead, that occur in a particular landscape. The type and quantity will depend upon soil, climate, terrain, and management and disturbance (e.g., fire) history. The major fuel groups of grass, grass/shrub, shrub, trees, tree litter, and slash are defined by their constituent types and quantities of litter and duff layers, dead woody material, grasses and forbs, shrubs, regeneration, and trees. Fire behavior can be predicted largely by analyzing the characteristics of these fuels. Fire behavior is affected by seven principal fuel characteristics: fuel loading, size and shape, compactness, horizontal continuity, vertical arrangement, moisture content, and chemical properties.

The seven principal fuel characteristics help define the 13 standard fire behavior fuel models (Anderson 1982). According to the model classifications, fuel models used for fire behavior modeling (BehavePlus, FlamMap, FARSITE) have been classified into four groups, based upon fuel loading (tons/acre), fuel height, and surface area-to-volume ratio. Observation of the fuels in the field determines which fuel models should be applied in modeling efforts. The following describes the distribution of fuel models among general vegetation types for the standard 13 fuel models:

- Grasses – Fuel Models 1 through 3
- Brush – Fuel Models 4 through 7
- Timber – Fuel Models 8 through 10
- Logging slash – Fuel Models 11 through 13

In addition, the aforementioned fuel characteristics were utilized in the development of 40 newer fire behavior fuel models (Scott and Burgan 2005) developed for use in the BehavePlus, FlamMap, and FARSITE modeling systems. These newer models attempt to improve the accuracy of the 13 standard fuel models and to allow for the simulation of fuel treatment prescriptions. The following describes the distribution of fuel models among general vegetation types for the 40 newer fuel models:

- Non-burnable – Models NB1, NB2, NB3, NB8, NB9
- Grass – Models GR1 through GR9
- Grass shrub – Models GS1 through GS4
- Shrub – Models SH1 through SH9
- Timber understory – Models TU1 through TU5
- Timber litter – Models TL1 through TL9
- Slash blowdown – Models SB1 through SB4.

FLAMMAP ANALYSIS

FlamMap software was utilized to graphically depict potential fire behavior in the Plan Area occurring during extreme fall weather conditions (off-shore, Diablo wind conditions). As noted, FlamMap software requires a minimum of five separate input files that represent field conditions in the analysis area, including elevation, slope, aspect, fuel model, and canopy cover. Given the extent of tree-dominated vegetation types in the Plan Area, stand height, canopy base height, and canopy bulk density input files were also incorporated. Each of these files was created as a raster GIS file using ArcGIS 10.5 software, exported as an ASCII grid file, then utilized in creating a FARSITE Landscape file that served as the base for the FlamMap runs. The resolution of each grid file and associated ASCII file that was used in the models described herein is approximately 3 meters (1/9 arc second), based on available digital terrain data (described below). In addition to the Landscape file, wind and weather data are incorporated into the model inputs. The output fire behavior variables chosen for the modeling runs include flame length and crown fire activity.

The analysis area selected for the fire behavior modeling effort included all of the canyon, ridgetop, and City parks lands and open space classifications (as described in Section 9.2 of the VMP). Urban and residential parcels, roadsides, medians, and other developed classifications were omitted as they fall within 100 feet of existing structures and within 30 feet of roads and management of vegetation in these areas would be classified as Priority 1.

The following provides descriptions of the input variables used in processing the FlamMap models. Data sources are cited and any assumptions made during the modeling process are described. Following the discussion of model inputs, a summary of model outputs is provided.

Model Inputs

Elevation

Elevation data were derived from a 1/9 arc-second resolution National Elevation Dataset (NED), acquired from the U.S. Geological Survey (USGS) National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center and projected in the NAD 1983, California State Plane, Zone 3 coordinate system, with units in feet (USGS 2013a, 2013b). Elevation values in the modeling area range from 72 feet to 1,545 feet above mean sea level (AMSL). This data was utilized to create an elevation grid file, using units of feet AMSL. Elevation is a required input file for FlamMap runs and are necessary for adiabatic adjustment of temperature and humidity and for conversion of fire spread between horizontal and slope distances.

Slope

Using ArcGIS Spatial Analyst tools, a slope grid file was generated from the elevation grid file described above. Slope measurements utilized values in percent of inclination from horizontal. Slope values in the analysis area range from 0% to 147%. The slope input file is necessary for computing slope effects on fire spread and solar radiance.

Aspect

Using ArcGIS Spatial Analyst tools, an aspect grid file was generated from the elevation grid file described above. The aspect values utilized were azimuth degrees. Aspect values are important in determining the solar exposure of grid cells.

Fuel Model

Vegetation coverage data in the form of a GIS shapefile were used in this analysis to create a fuel model file for existing conditions, which was derived from the vegetation community/land cover type data mapped for the Plan Area (Appendix B). Using the vegetation community/land cover type data, field assessments were conducted to classify the different types into appropriate fuel models. In many areas, different fuel models were assigned to the same mapped vegetation community/land cover type (e.g., eucalyptus) based on observed field conditions and management history, which required subdividing some vegetation community/land cover polygons. For example, a tree-dominated vegetation type may be classified as a timber litter model if the understory consisted of dead and downed leaves and woody fuel, or as a grass model if the understory had been subject to management (e.g., grazing) that reduced surface fuel loads to grasses. Once fuel model values were assigned to vegetation community/land cover type polygons, the vector-based fuel model data file was converted to a grid file for inclusion in FlamMap modeling.

A photo series presenting representative field photographs of each of the different fuel models used in this analysis is presented in Appendix C-1. A map of fuel types for the analysis area is presented in Appendix C-2. Fuel model assignments for existing vegetation conditions are presented in Table C-1.

Canopy Cover

Canopy cover is a required raster file for FlamMap operations. It is necessary for computing shading and wind reduction factors for all fuel models. Canopy cover is measured as the horizontal fraction of the ground that is covered directly overhead by tree canopy. Crown closure refers to the ecological condition of relative tree crown density. Stands can be said to be "closed" to recruitment of canopy trees but still only have 40% or 50% canopy cover. Coverage units can be categories (0–4) or percentage values (0–100) (Seli et al. 2015).

Canopy cover for the analysis area was derived from 2012 LiDAR tree canopy cover data made available by the California Department of Forestry and Fire Protection (CAL FIRE 2015). This dataset was converted from raster to vector format in a GIS and the data analyzed for the analysis area. Minor edits to the dataset were made based on field observations and comparison with digital aerial photos. The file was then converted back to raster format and included two values representing percent of tree canopy cover: 0 (no tree canopy) and 100 (tree canopy).

Stand Height

Stand height is a representation of the average height of dominant and co-dominant trees in a stand (not the tallest height or average height of all trees) and is used in FlamMap for computing wind reduction to midflame height and spotting distances from torching trees. Input values are numeric (Seli et al. 2015). For this analysis, stand height values are represented in feet. Stand height is a necessary dataset for utilizing the torching, spotting, and crown fire model in FlamMap. As described, field evaluations conducted to define fuel model assignments also included identification of stand height values for tree-dominated vegetation types. The stand height assignments are presented in Table D-1, by fuel model.

Canopy Base Height

Canopy base height is a variable used for determining transition from surface fire to crown fire and represents the height to the bottom of the live tree crown. Input values are numeric (Seli et al. 2015). For this analysis, canopy base height values are represented in feet. Canopy base height is a necessary dataset for utilizing the torching, spotting, and crown fire model in FlamMap. As described, field evaluations conducted to define fuel model assignments also included identification of canopy base height values for tree-dominated vegetation types. Observed base heights were typically correlated with management history. For example, grazed areas (beneath trees) typically had 4-foot to 5-foot base heights, the heights that goats grazed up to. In areas where hand crews had treated surface vegetation, 8-foot base heights were typically observed. The stand height assignments are presented in Table D-1, by fuel model.

Canopy Bulk Density

Canopy bulk density is incorporated to determine the characteristics of crown fires and describes the density of available canopy fuel in a stand. It is defined as the mass of available canopy fuel per canopy volume unit. Input values are numeric (Seli et al. 2015). For this analysis, canopy bulk density values are represented in kg/m^3x100 (kilograms per cubic meter x 100). Canopy bulk density is a necessary data set for utilizing the torching, spotting, and crown fire model in FlamMap. Data for the analysis area were derived from an analysis of canopy bulk density data for the Plan Area (LANDFIRE 2017).

Table D-1 provides a description of fuel models (including one non-burnable model) coded for the Plan Area that were subsequently used in the FlamMap analysis.

Table C-1
Fuel Model Characteristics

Fuel Model	Description	Land Cover*	Stand Height (feet)	Canopy Base Height (feet)
GR1 (101)	Short, Sparse Dry Climate Grass	Annual Grassland, Closed-Cone Pine-Cypress, Coast Oak Woodland, Eucalyptus, Perennial Grassland, Redwood, Urban	0, 35, 40, 45, 50, 60, 65, 80, 100, 110	0, 3, 4, 5, 8
GR4 (104)	Moderate Load, Dry Climate Grass	Annual Grassland	0	0
GS2 (122)	Moderate Load, Dry Climate Grass-Shrub	Coast Oak Woodland, Coastal Scrub, Eucalyptus	0, 25, 35, 40, 60	0, 2, 3, 4
SH1 (141)	Low Load, Dry Climate Shrub	Coastal Scrub	0	0
SH5 (145)	High Load, Dry Climate Shrub	Mixed Chaparral, Closed-Cone Pine-Cypress, Coast Oak Woodland, Coastal Scrub, Eucalyptus	0, 25, 30, 35, 40, 60, 100, 110	0, 2, 3, 4
TU1 (161)	Low Load, Dry Climate Timber-Grass-Shrub	Closed-Cone Pine-Cypress, Coast Oak Woodland, Eucalyptus, Redwood	0, 45, 60, 100, 110	4, 6, 8
TU5 (165)	Very High Load, Dry Climate Timber-Shrub	Closed-Cone Pine-Cypress, Coast Oak Woodland, Eucalyptus, Urban (acacia and mixed tree stand)	0, 35, 40, 45, 60, 75, 100, 110, 120	2, 3, 4, 8
TL2 (182)	Low Load Broadleaf Litter	Coast Oak Woodland, Eucalyptus, Urban, Valley/Foothill Riparian	30, 35, 40, 45, 60, 100, 110	3, 4, 5
TL3 (183)	Moderate Load Conifer Litter	Closed-Cone Pine-Cypress, Eucalyptus, Redwood	60, 110	4
TL6 (186)	Moderate Load Broadleaf Litter	Eucalyptus, Urban	80, 110	4, 8

Fuel Model	Description	Land Cover*	Stand Height (feet)	Canopy Base Height (feet)
TL8 (188)	Long Needle Litter	Closed-Cone Pine-Cypress	35, 100	4
TL9 (189)	Very High Load Broadleaf Litter	Eucalyptus	100	8
NB1 (91)	Non-burnable	Freshwater Emergent Wetland, Urban	0, 35, 40	0, 2, 4

Note: * As mapped by Horizon (2017; Appendix B).

Weather

Historical weather data for the Plan Area was utilized in determining appropriate fire behavior modeling inputs. For this analysis, 97th percentile fuel moisture and wind speed values were derived from Remote Automated Weather Station (RAWS) data and utilized in the fire behavior modeling efforts conducted in support of this VMP. Data from two RAWS in the Plan Area was utilized for modeling fire behavior, including the Oakland (North) RAWS (approximately 250 feet north of the City-owned Grizzly Peak Open Space parcels), and the Oakland (South) RAWS (located in the central portion of the Plan Area, on the City Stables property). Table D-2 summarizes location information and available data ranges for these two RAWS.

Table C-2
Remote Automated Weather Station Characteristics

Station Characteristic	Oakland (North)	Oakland (South)
Latitude	37° 51' 54"	37° 47' 10"
Longitude	-122° 13' 15"	-122° 08' 41"
Elevation	1,403 feet	1,095 feet
Data Years	1981, 1984, 1988, 1995-2016	1995-2016

To determine weather-related modeling inputs, RAWS fuel moisture and wind speed data were downloaded, processed, and analyzed using the FireFamilyPlus version 4.2 (FireFamilyPlus 2016) software package to determine 97th percentile (extreme) fire weather conditions. Data from the two RAWS was combined into a Special Interest Group (SIG) in the FireFamilyPlus software, with data from each station being weighted equally. The project SIG was evaluated from August 15 through November 15 for each year between 1995 and 2016 (extent of available data record). Data derived from this analysis included 97th percentile values for 1-hour, 10-hour, and 100-hour fuel moistures, live herbaceous moisture, live woody moisture, and 20-foot sustained wind speed. The weather data was also evaluated to determine the maximum sustained wind.

These weather values were incorporated into the Initial Fuel Moisture file used as an input in FlamMap. Wind direction and wind speed values for the FlamMap run were manually entered during the data input phase. Table D-3 presents the wind and weather values used in the FlamMap fire behavior modeling runs conducted in support of this VMP.

Table C-3
FlamMap Weather Input Variables

Model Variable	Value
1-hour fuel moisture	3%
10-hour fuel moisture	4%
100-hour fuel moisture	8%
Live herbaceous moisture*	30%
Live woody moisture	59%
20-foot wind speed (mph)	39 mph (maximum speed)
Wind direction	60 degrees

Note: * Live herbaceous moisture values were lower than 30% so the herbaceous fuels are considered fully cured (Scott and Burgan 2005).

Finally, wind vectors were modeled within the FlamMap runs using the WindNinja tool embedded in the FlamMap software. WindNinja models the effect of topography on wind speed and direction and generates wind vector files for use in the modeling runs. The grid resolution for the WindNinja analysis was set at 60 meters.

Model Outputs

Two output grid files were generated for the FlamMap run and represent flame length and crown fire activity. Flame length, the length of the flame of a spreading surface fire within the flaming front, is measured from midway in the active flaming combustion zone to the average tip of the flames (Andrews et al. 2008). It is a somewhat subjective and non-scientific measure of fire behavior, but is extremely important to fireline personnel in evaluating fireline intensity and is worth considering as an important fire variable (Rothermel 1993). Flame length values in the resulting grid file are in feet. Table 5 in the VMP presents an interpretation of flame length and its relationship to fireline intensity. Model outputs for crown fire activity include three potential options: surface fire, passive crown fire (torching), or active crown fire. Surface fires may transition to crown fire, depending on surface fire intensity and crown characteristics. Ladder fuels facilitate ignition of crown fuels by the surface fire and then transition to some form of crown fire (Seli et al. 2015).

Maps depicting flame length values and crown fire activity values are presented in Appendices C-3 and C-4, respectively. Table C-4 summarizes the fire behavior modeling results, by location.

Table C-4
Fire Behavior Modeling Results

Location	Flame Length	Crown Fire
Canyon Areas		
Garber Park	Flame lengths low (< 4 feet).	Surface fire only.
Dimond Canyon Park	Flame lengths high (> 8 feet) in coastal scrub and one coastal oak woodland area along Park Boulevard with grass/shrub understory. Flame lengths low to moderate (< 8 feet) in remaining areas of the property.	Primarily surface fire throughout the property, although small pockets of active crown fire occur the coastal oak woodland area along Park Boulevard with grass/shrub understory and in a few small areas within the drainage with high slope gradients.
Shepherd Canyon Park	Flame lengths high (> 8 feet) in area along the western side of Shepherd Canyon Road where broom exists beneath eucalyptus tree canopies. Flame lengths moderate (< 8 feet) within eucalyptus stand along Escher Drive. Flame lengths low (< 4 feet) throughout the remainder of the property.	Active and passive crown fire concentrated along the western side of Shepherd Canyon Road where broom exists beneath eucalyptus tree canopies. Surface fire throughout the remainder of the property.
Leona Heights Park	Flame lengths high (> 8 feet) in coastal oak woodlands in upland areas in the eastern and northern portions of the park. Flame lengths low (< 4 feet) within redwood stands along the drainage bottom, with some isolated active crown fire in areas with steep slope gradients. Flame lengths low (< 4 feet) within the managed eucalyptus and oak stands at the park's western edge.	Active and passive crown fire in coastal oak woodlands in upland areas in the eastern and northern portions of the park. Primarily surface fire within redwood stands along the drainage bottom, with some isolated active crown fire in areas with steep slope gradients. Surface fire only in the managed eucalyptus and oak stands at the park's western edge.
Beaconsfield Canyon	Flame lengths high (> 8 feet) in coastal scrub. Flame lengths low to moderate (< 8 feet) in coastal oak woodland and pine stands.	Active and passive crown fire in eucalyptus stands. Surface fire in coastal oak woodland and pine stands.
Ridgetop Areas		
North Oakland Regional Sports Field	Flame lengths high (> 8 feet) throughout property.	Active crown fire throughout most of the property's tree-dominated vegetation (eucalyptus and coastal oak woodland). Surface fire concentrated in managed areas along dirt access road and in area between ball field and eucalyptus stand.
Grizzly Peak Open Space	Flame lengths high (> 8 feet) throughout coastal scrub vegetation. Flame lengths low (< 4 feet) in coastal oak woodland. Variable flame lengths within pine and eucalyptus stands (low to high, dependent on canopy base heights and shading of surface fuels).	Torching of tree canopies along upper, northeastern portion of property and active crown fire along lower, southwestern portion of property.

Location	Flame Length	Crown Fire
City Stables	Flame lengths low (< 4 feet).	Surface fire only.
City Parklands and Open Space		
Sheffield Village Open Space	Flame lengths high (> 8 feet) in coastal scrub, oak stands with a heavy shrub understory, and isolated areas within oak woodlands with grass understory where slope gradients are high. Flame lengths moderate (< 8 feet) in pine and eucalyptus stands adjacent to the golf course. Flame lengths low (< 4 feet) throughout the remainder of the property.	Active crown fire in coastal scrub (where overstory trees are present), oak stands with a heavy shrub understory, and isolated areas within oak woodlands with grass understory where slope gradients are high. Surface fire only throughout the remainder of the property.
Knowland Park and Arboretum	Flame lengths high (> 8 feet) in the coastal scrub and chaparral stands in the central and eastern portions of the property. Flame lengths moderate (< 8 feet) in the eucalyptus stands in the western portion of the property. Flame lengths low (< 4 feet) throughout the remainder of the property.	Active crown fire in the coastal scrub and chaparral stands in the central and eastern portions of the property (where overstory trees are present) and in the eucalyptus stands in the western portion of the property. Surface fire only throughout the remainder of the property.
Joaquin Miller Park	Flame lengths high (> 8 feet) throughout the northern and central portions of the park within non-managed oak, pine, eucalyptus, and acacia stands and within the acacia and mixed tree stands within the southern (lower) portions of the park. Flame lengths low to moderate (< 8 feet) in the lower, developed and managed portions of the park and along the park's western edge where it abuts Castle Drive (except acacia and mixed tree stands).	Active and passive crown fire within the northern and central portions of the park within non-managed oak, pine, eucalyptus, and acacia stands. Active and passive crown fire also within the acacia and mixed tree stands within the southern (lower) portions of the park. Surface fire only within redwood stands and throughout the lower, developed and managed portions of the park (except acacia and mixed tree stands).
King Estate open Space Park	Flame lengths low (< 4 feet) throughout the property's coastal oak woodlands and grasslands. Flame lengths moderate (< 8 feet) to high (>8 feet) in the coastal scrub areas of the property.	Isolated active crown fire only in coastal scrub where overstory trees are present. Surface fire only throughout the remainder of the property.
Other (Blue Rock Court)	Flame lengths high (> 8 feet) in the eucalyptus stand in the center of the property. Flame lengths low (< 4 feet) throughout the remainder of the property.	Active and passive crown fire in the eucalyptus stand in the center of the property. Surface fire only throughout the remainder of the property.
Other (Leona Street)	Flame lengths low (< 4 feet) in coastal oak woodland and annual grassland. Flame lengths high (> 8 feet) in eucalyptus stand at the property's southern end.	Surface fire only in coastal oak woodland and annual grassland. Active crown fire in eucalyptus stand at the property's southern end.
Other (McDonell Avenue)	Flame lengths low (< 4 feet).	Surface fire only.
Other (Police/Safety Department)	Flame lengths low (< 4 feet).	Surface fire only.
Other (Tunnel Road Open Space)	Flame lengths low (< 4 feet).	Surface fire only.

Location	Flame Length	Crown Fire
Other (Marjorie Saunders Park)	Flame lengths high (> 8 feet) in eucalyptus stands. Flame lengths low to moderate (< 8 feet) in coastal oak woodland and pine stands.	Active and passive crown fire in coastal scrub (where overstory trees are present). Surface fire in coastal oak woodland and pine stands.
Other (Oak Knoll)	Flame lengths low (< 4 feet) throughout the property's grasslands. Flame lengths moderate (< 8 feet) in the property's eucalyptus stand.	Surface fire only throughout the remainder of the property.

APPENDIX C-1

Fuel Model Photo Series

Photo 1. Fuel Model GR4 (104) - Moderate Load, Dry Climate Grass.
Higher fire hazard, non-grazed grassland (King Estate Open Space Park, January 5, 2017).

Photo 2. Fuel Model GR1 (101) - Short, Sparse Dry Climate Grass.
Lower fire hazard, grazed grassland (King Estate Open Space Park, September 12, 2017).

Photo 3. Fuel Model GR1 (101) - Short, Sparse Dry Climate Grass.
Lower fire hazard, grazed grasses with eucalyptus overstory (Skyline Boulevard, September 11, 2017).

Photo 4. Fuel Model GR1 (101) - Short, Sparse Dry Climate Grass.
Lower fire hazard, grazed grasses with oak overstory (Shepherd Canyon Park, September 11, 2017).

Photo 5. Fuel Model GS2 (122) - Moderate Load, Dry Climate Grass-Shrub.
Higher fire hazard, un-grazed grasses with scattered shrubs and eucalyptus sprout growth (North Oakland Regional Sports Field, September 11, 2017).

Photo 6. Fuel Model GS2 (122) - Moderate Load, Dry Climate Grass-Shrub.
Lower fire hazard, grazed grasses with scattered shrubs (Grizzly Peak Open Space, September 12, 2017).

Photo 7. Fuel Model SH1 (141) - Low Load, Dry Climate Shrub.
Lower fire hazard, grazed grasses between shrubs (King Estate Open Space Park, September 12, 2017).

Photo 8. Fuel Model SH5 (145) - High Load, Dry Climate Shrub.
Higher fire hazard, high brush load with scattered oak and eucalyptus trees (North Oakland Regional Sports Field, September 11, 2017).

Photo 9. Fuel Model SH5 (145) - High Load, Dry Climate Shrub.
Higher fire hazard, high brush load (coastal scrub) (Sheffield Village Open Space, September 12, 2017).

Photo 10. Fuel Model SH5 (145) - High Load, Dry Climate Shrub.
Higher fire hazard, high brush load beneath young eucalyptus trees (North Oakland Regional Sports Field, September 11, 2017).

Photo 11. Fuel Model TU1 (161) - Low Load, Dry Climate Timber-Grass-Shrub.
Higher fire hazard, eucalyptus with broom understory (Shepherd Canyon Park, September 11, 2017).

Photo 12. Fuel Model TU1 (161) - Low Load, Dry Climate Timber-Grass-Shrub.
Higher fire hazard, un-grazed grass and shrub understory with oak, pine, and bay overstory (Marjorie Saunders Park, September 12, 2017).

Photo 13. Fuel Model TU1 (161) - Low Load, Dry Climate Timber-Grass-Shrub.
Lower fire hazard, redwood with seedling understory (Joaquin Miller Park, September 12, 2017).

Photo 14. Fuel Model TU5 (165) - Very High Load, Dry Climate Timber-Shrub.
Higher fire hazard, eucalyptus overstory with seedling and brush understory (North Oakland Regional Sports Field, September 11, 2017).

Photo 15. Fuel Model TU5 (165) - Very High Load, Dry Climate Timber-Shrub.
Higher fire hazard, pine and oak overstory with seedling and brush understory (Joaquin Miller Park, September 12, 2017).

Photo 16. Fuel Model TL2 (182) - Low Load Broadleaf Litter.
Lower fire hazard, oak woodland with twig and leaf litter surface fuels (Sheffield Village Open Space, September 12, 2017).

Photo 17. Fuel Model TL2 (182) - Low Load Broadleaf Litter.
Lower fire hazard, oak woodland with fern, ivy, leaf litter surface fuels (Garber Park, September 13. 2017).

Photo 18. Fuel Model TL3 (183) - Moderate Load Conifer Litter.
Lower fire hazard, redwood stand with needle litter and small twig/branch surface fuels (Joaquin Miller Park, September 12, 2017).

Photo 19. Fuel Model TL6 (186) - Moderate Load Broadleaf Litter.
Lower fire hazard, eucalyptus stand with leaf litter and small twig/branch surface fuels (Shepherd Canyon Park, January 19, 2017).

Photo 20. Fuel Model TL8 (188) - Long Needle Litter.
Lower fire hazard, pine stand with needle litter and low grass surface fuels (Joaquin Miller Park, September 12, 2017).

Photo 21. Fuel Model TL9 (189) - Very High Load Broadleaf Litter.
Higher fire hazard, eucalyptus stand with heavy leaf litter, bark, and small twig/branch surface fuels (North Oakland Regional Sports Field, January 19, 2017).

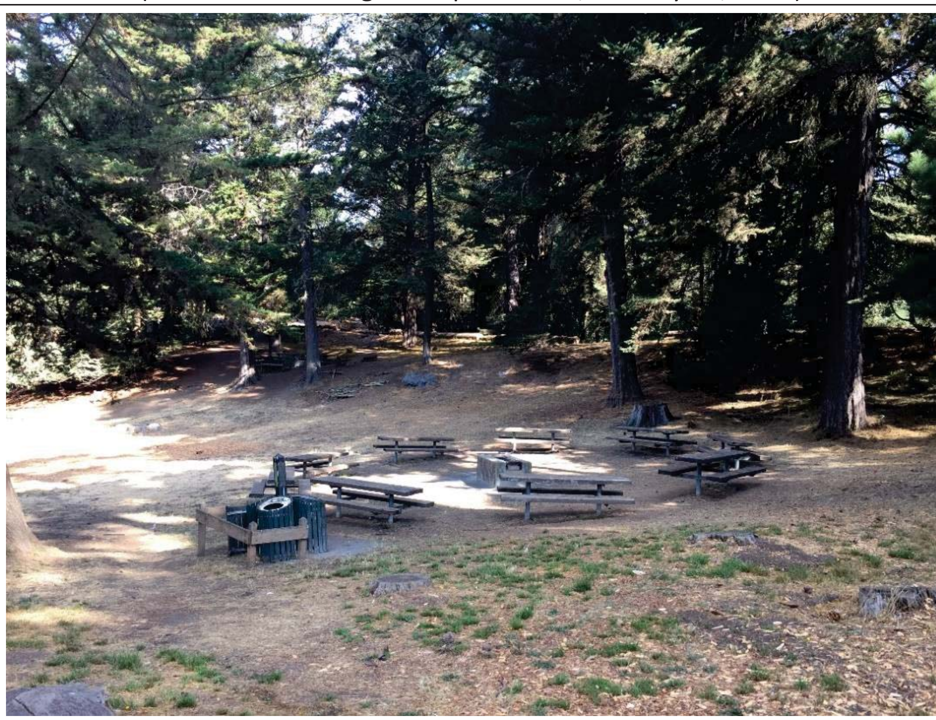
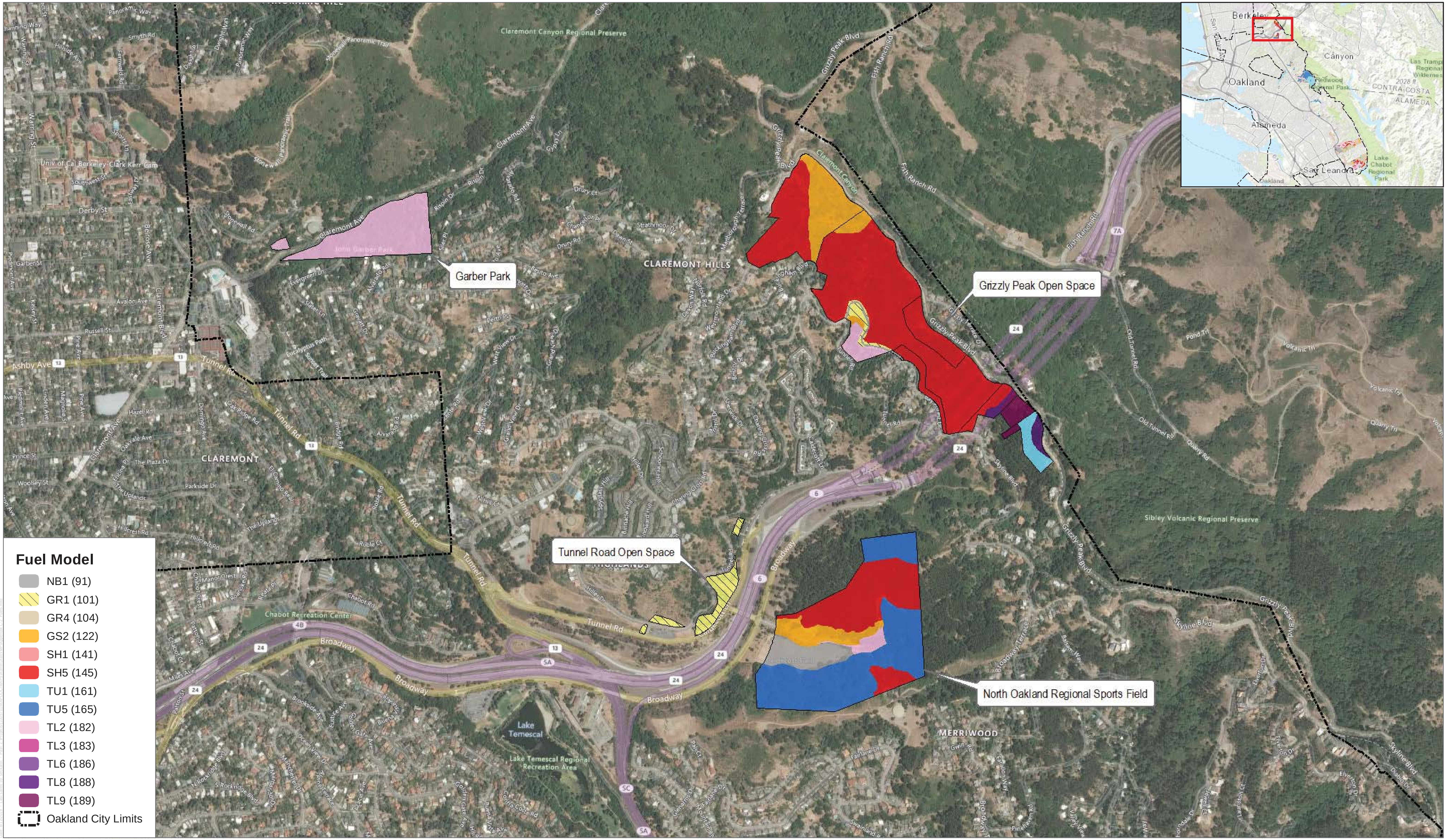


Photo 22. Fuel Model NB1 (91) - Developed.
Developed, dirt, or paved areas, no fire spread (Joaquin Miller Park, September 12, 2017).

APPENDIX C-2

Maps – Fuel Types



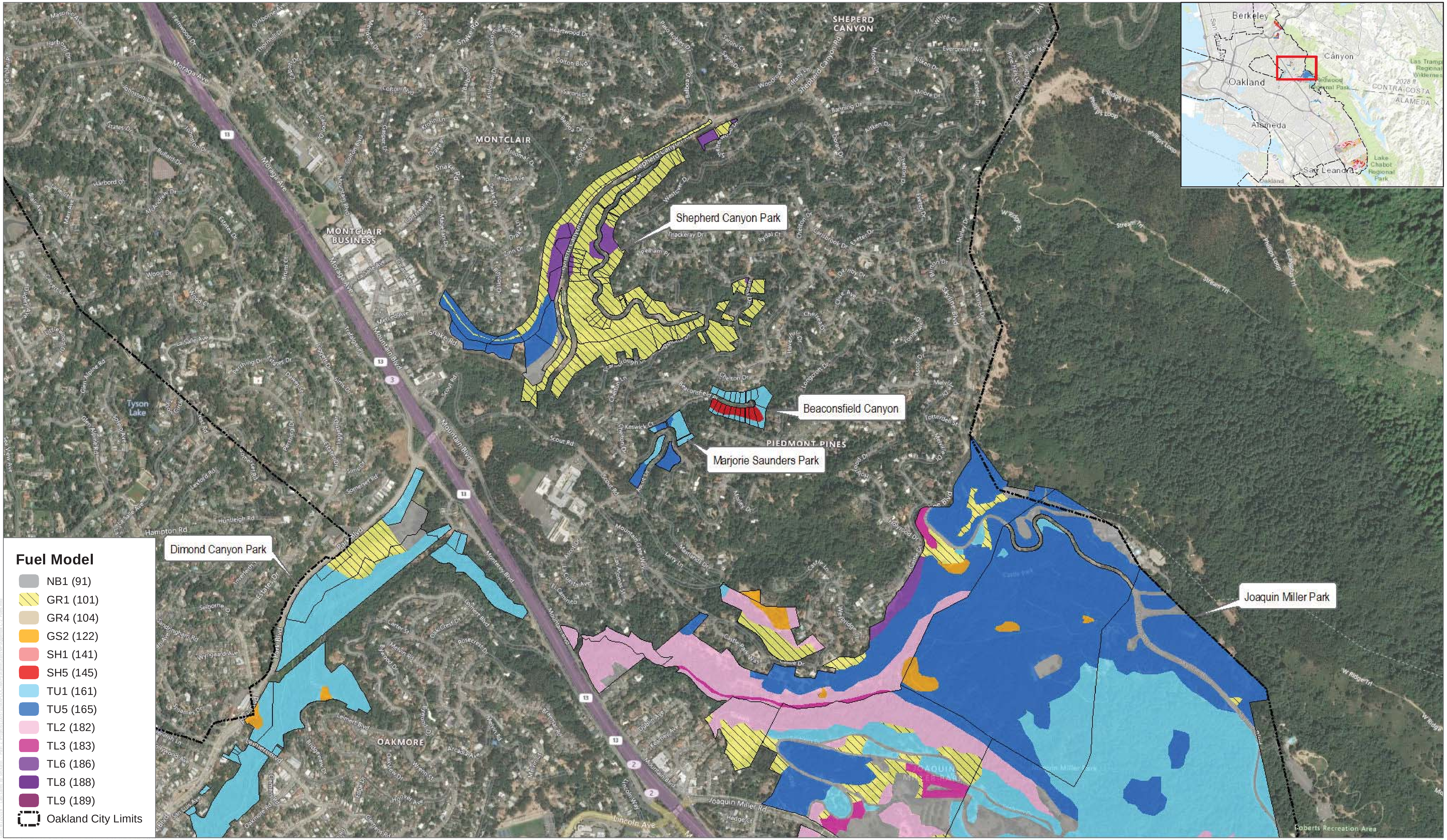
SOURCE: USGS 2017; ESRI 2017; Dudek 2017

DUDEK

0 487.5 975 Feet

APPENDIX C-2

Fuel Types



SOURCE: USGS 2017; ESRI 2017; Dudek 2017

APPENDIX C-2

Fuel Types

DUDEK

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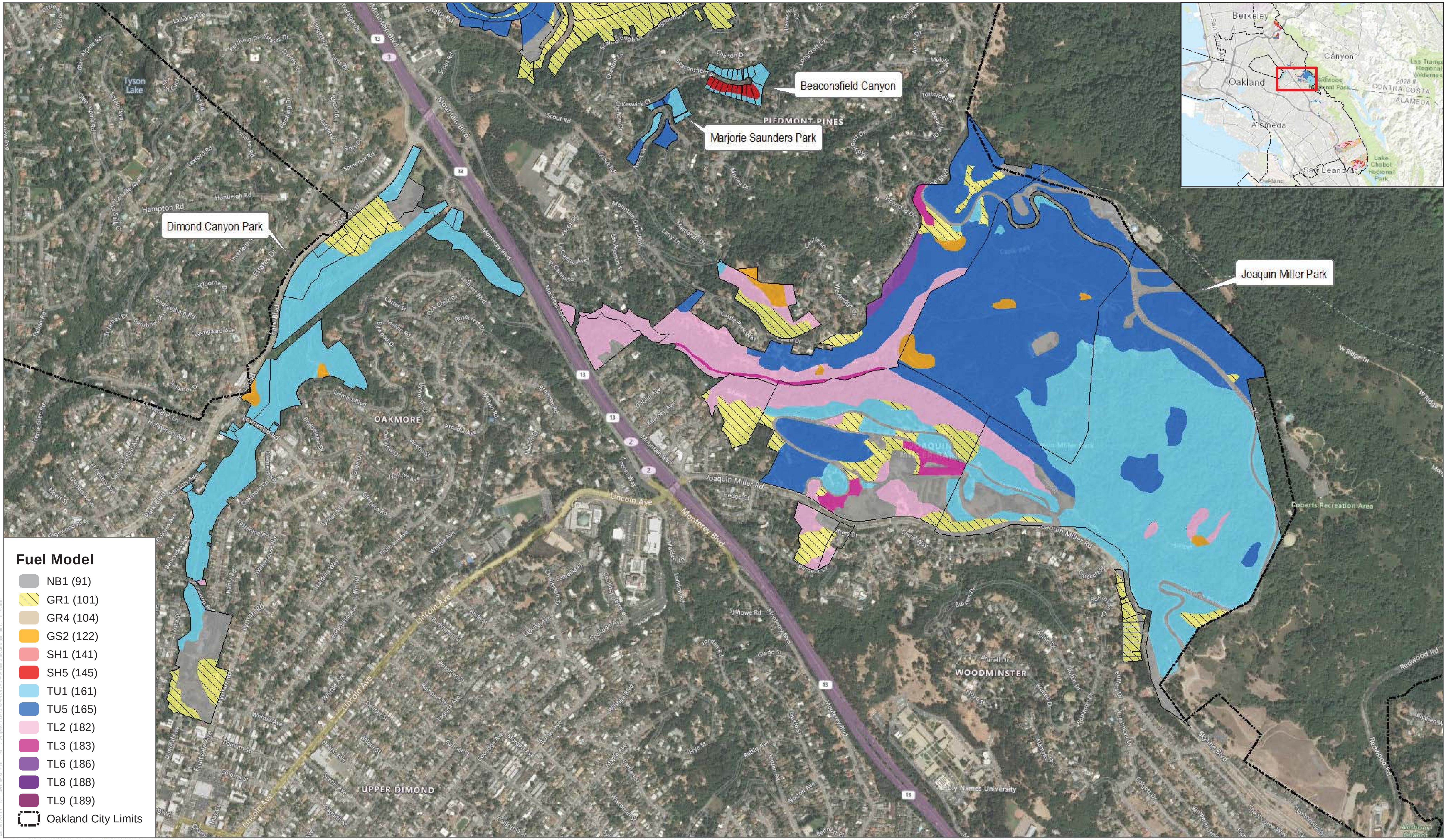

SOURCE: USGS 2017; ESRI 2017; Dudek 2017

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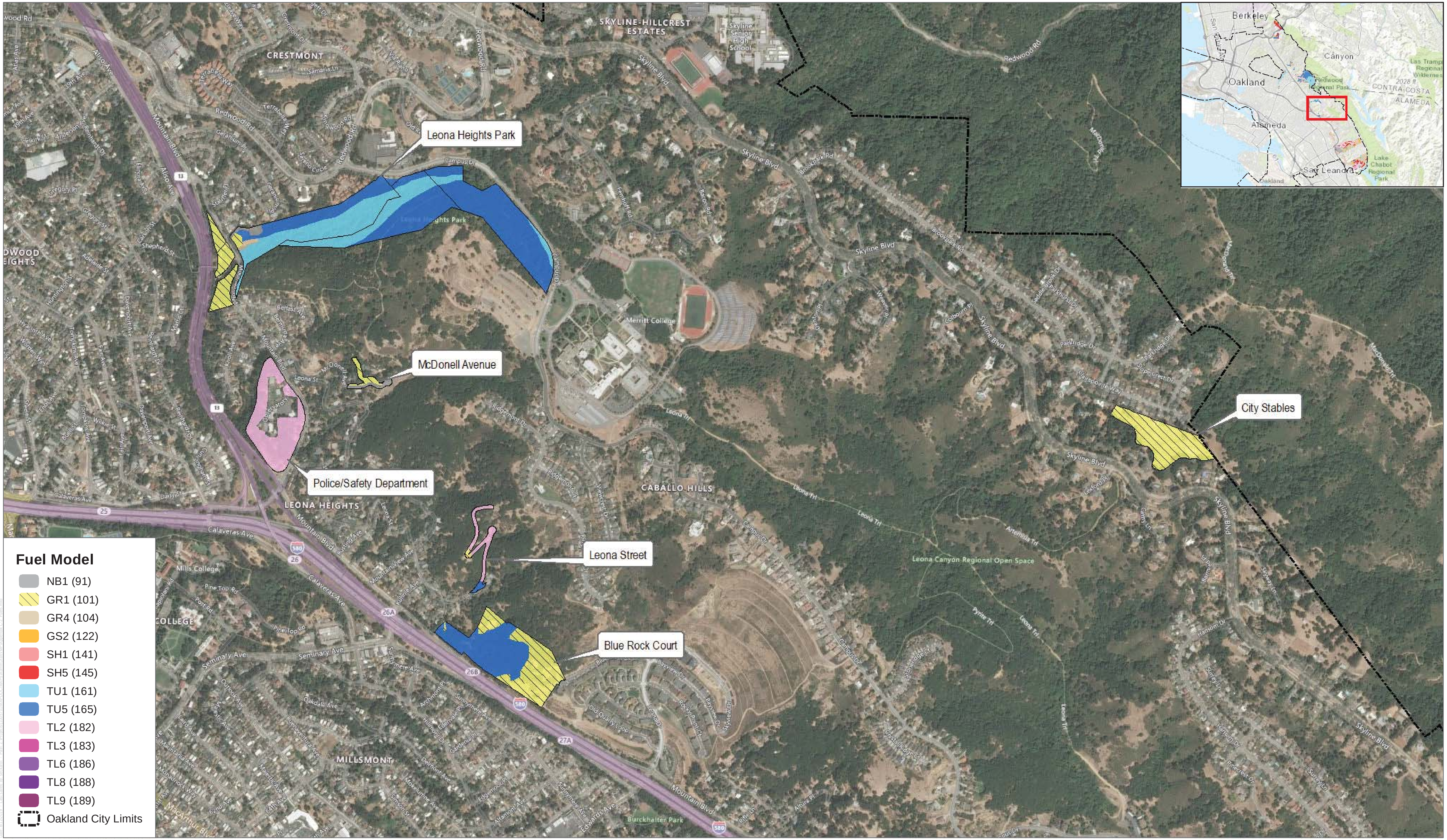
APPENDIX C-2

Fuel Types



SOURCE: USGS 2017; ESRI 2017; Dudek 2017

DUDEK

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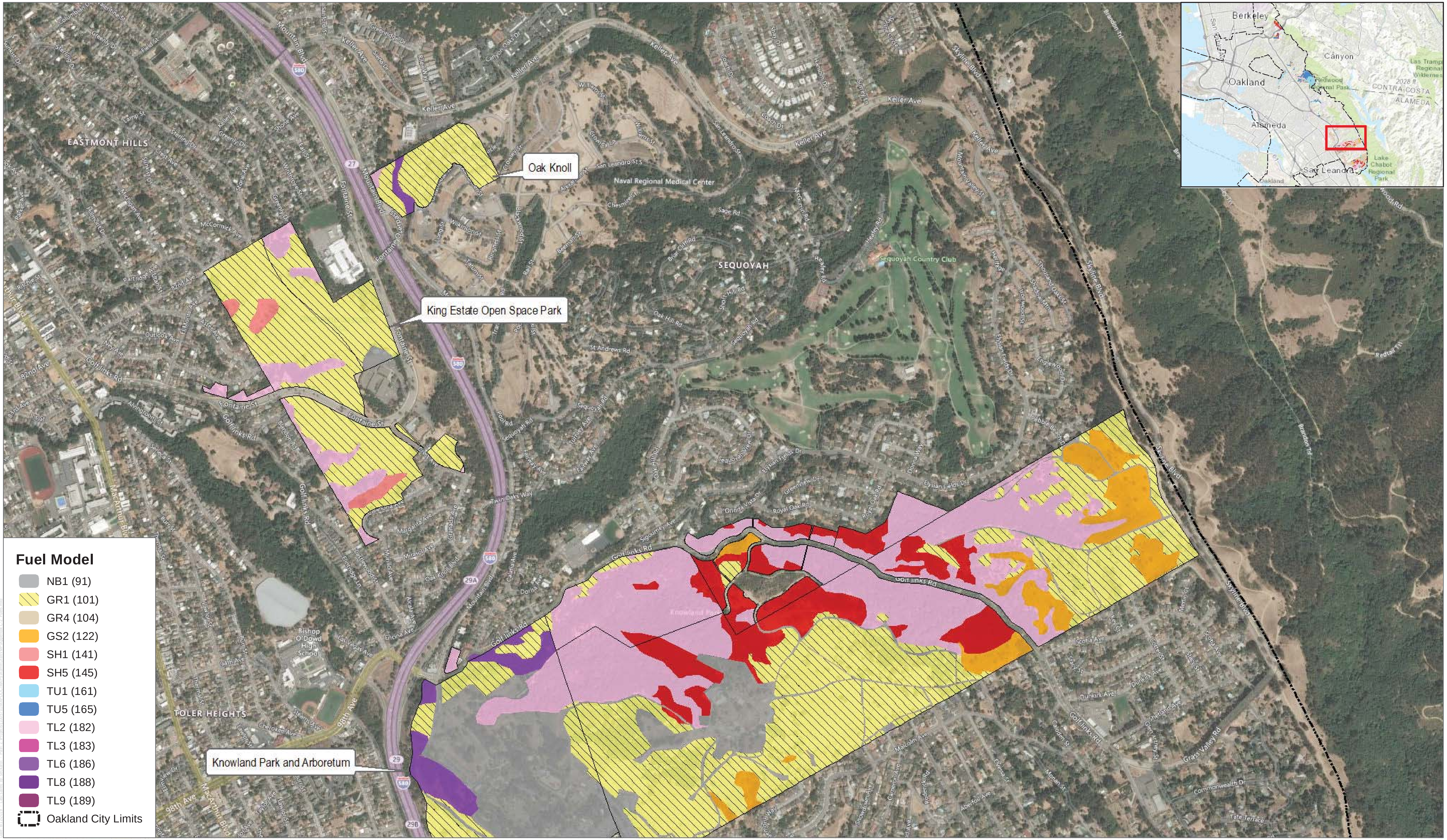
APPENDIX C-2

Fuel Types



SOURCE: USGS 2017; ESRI 2017; Dudek 2017

DUDEK

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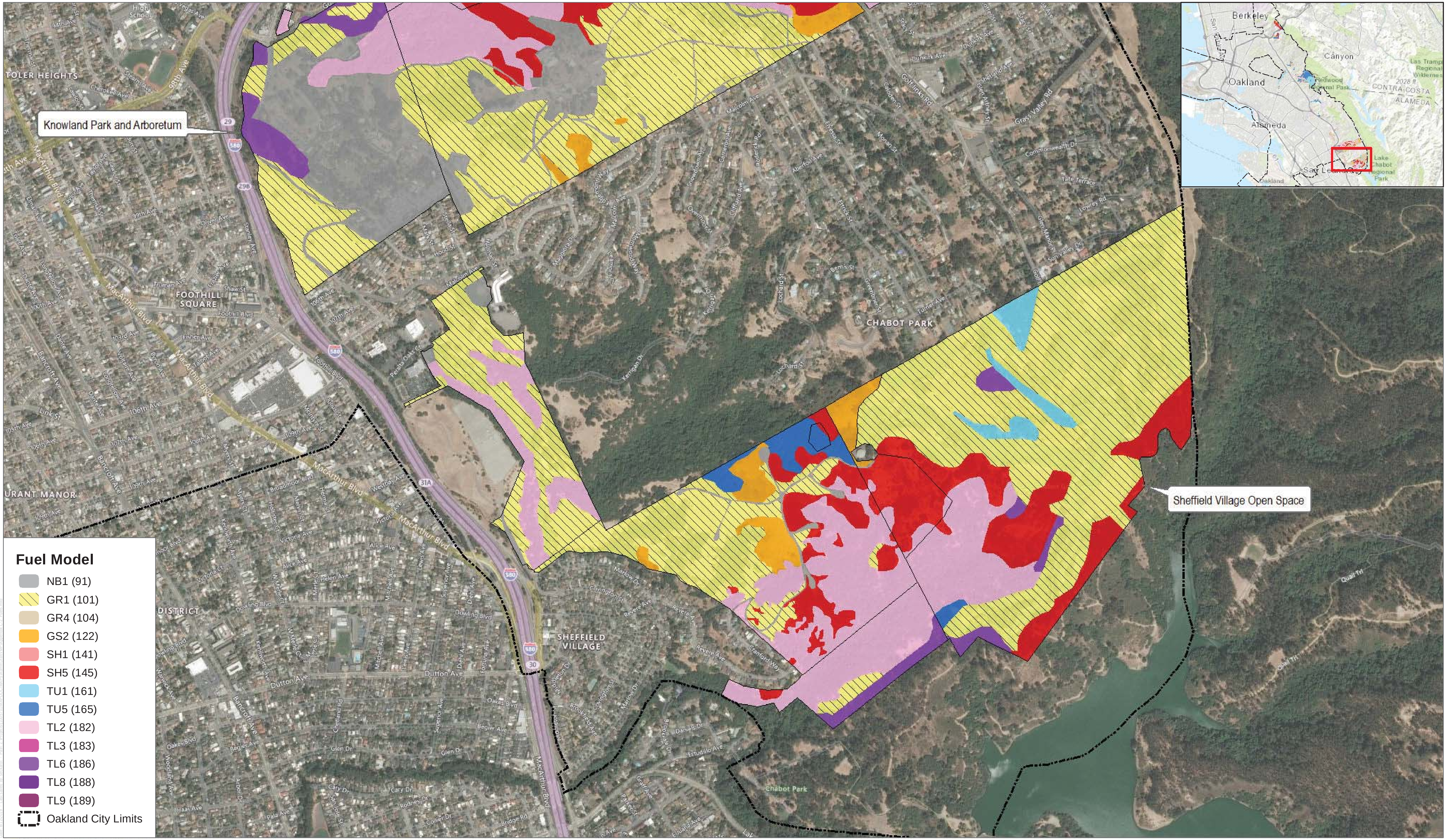
APPENDIX C-2

Fuel Types



SOURCE: USGS 2017; ESRI 2017; Dudek 2017

DUDEK

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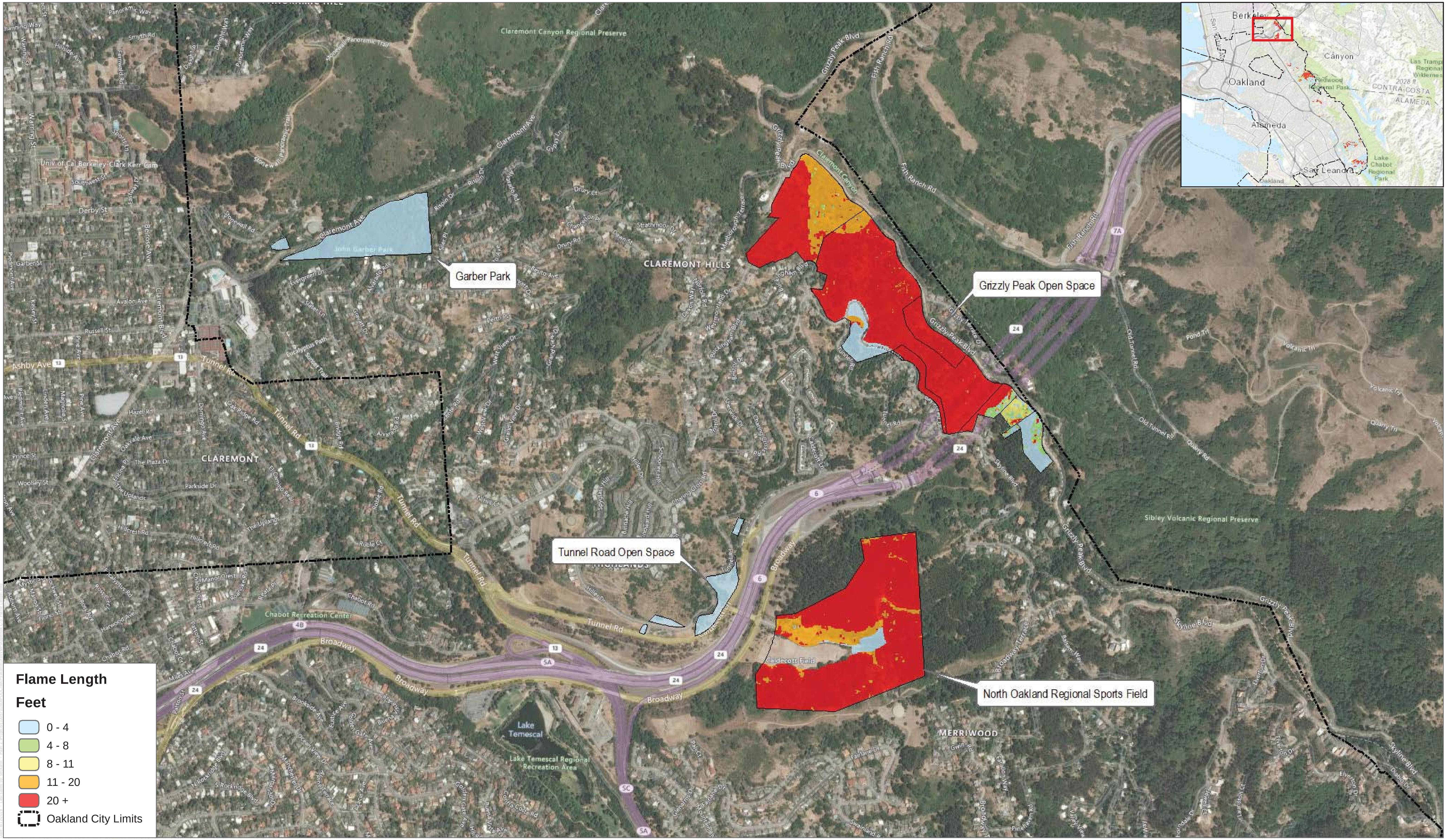
APPENDIX C-2

Fuel Types

APPENDIX C-3

Maps – Fire Behavior (Flame Length)



SOURCE: USGS 2017; ESRI 2017; Dudek 2017

DUDEK

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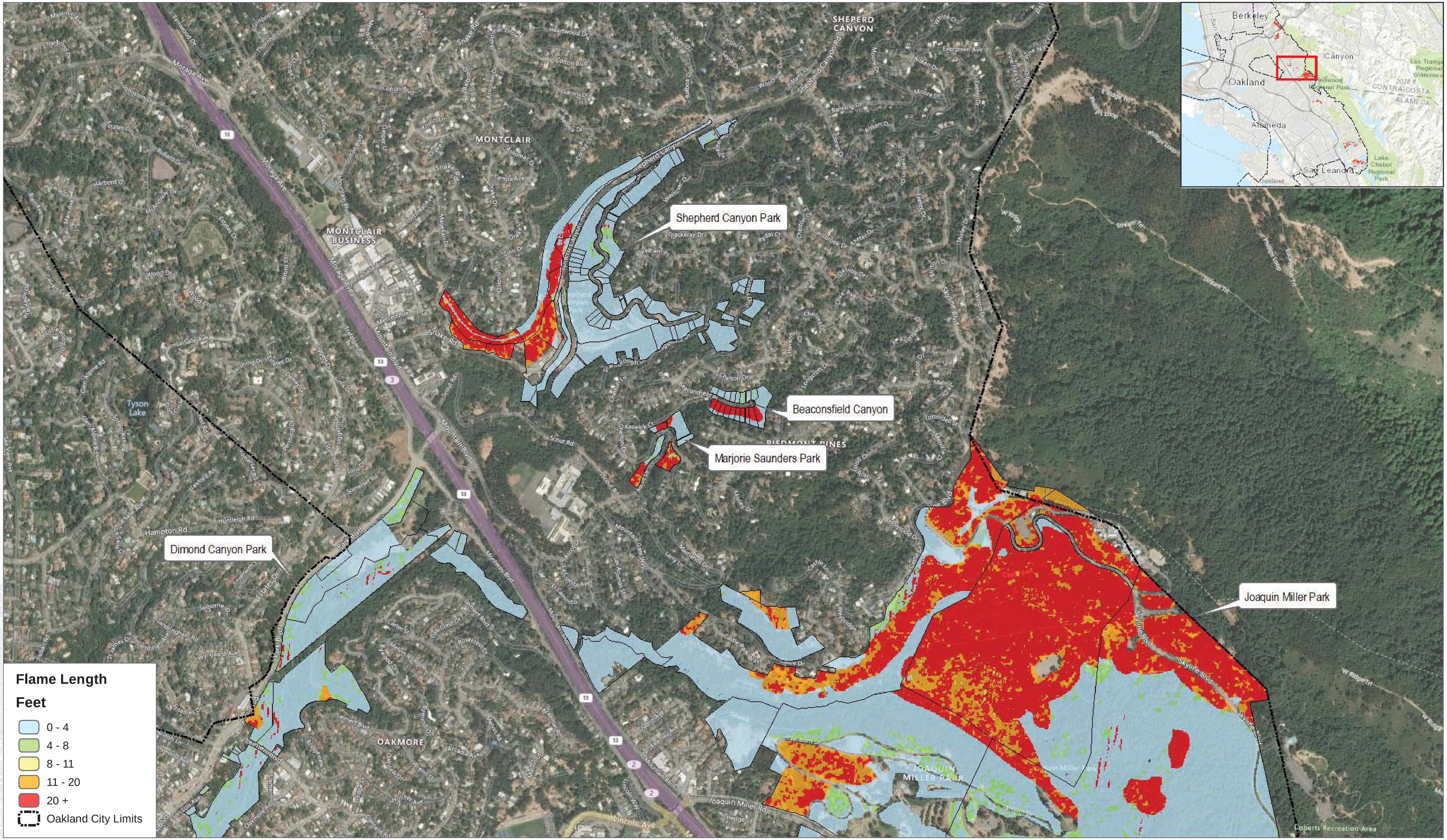
APPENDIX C-3

Fire Behavior (Flame Length)



SOURCE: USGS 2017; ESRI 2017; Dudek 2017

DUDEK

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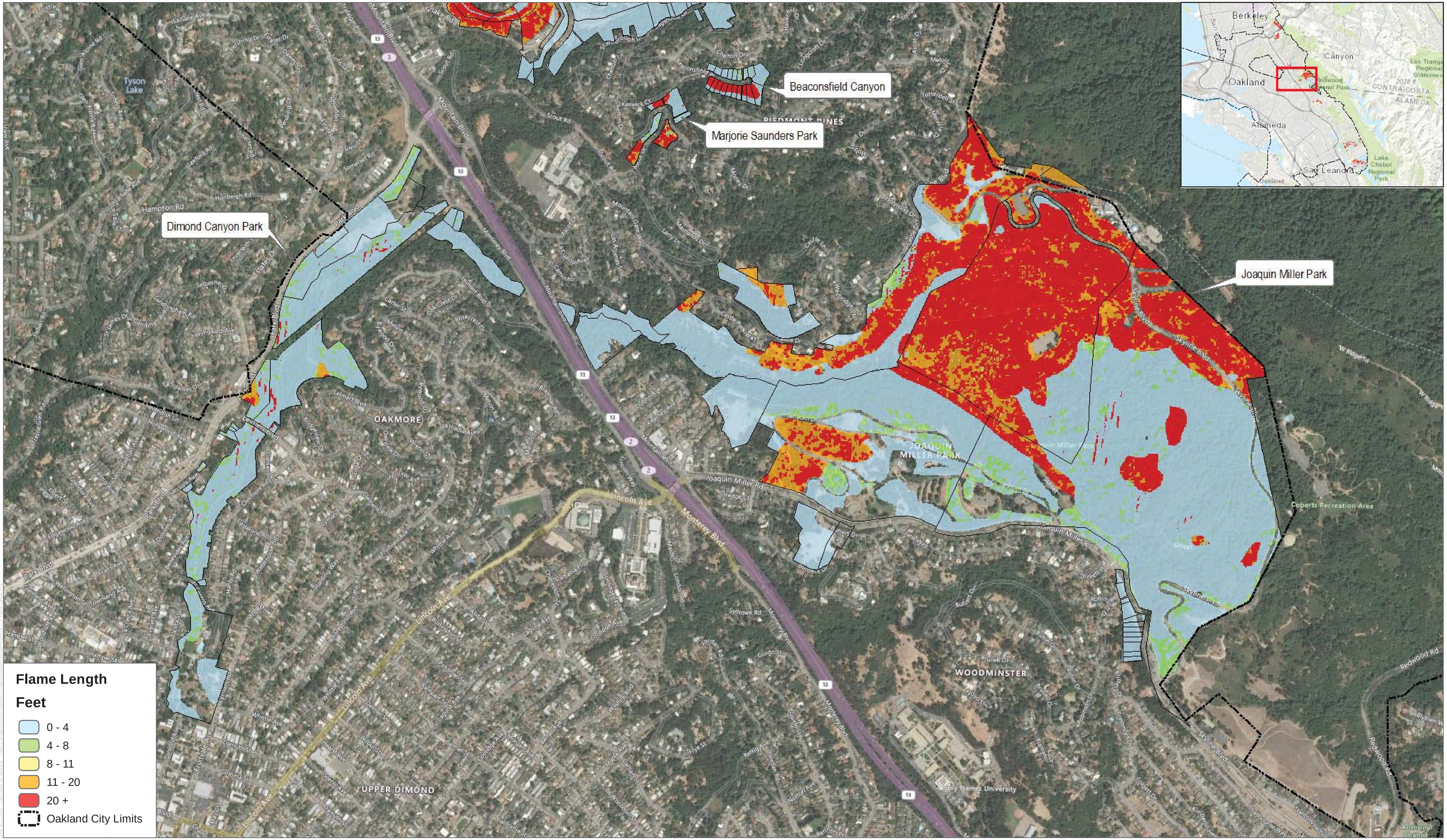
APPENDIX C-3

Fire Behavior (Flame Length)



SOURCE: USGS 2017; ESRI 2017; Dudek 2017

DUDEK

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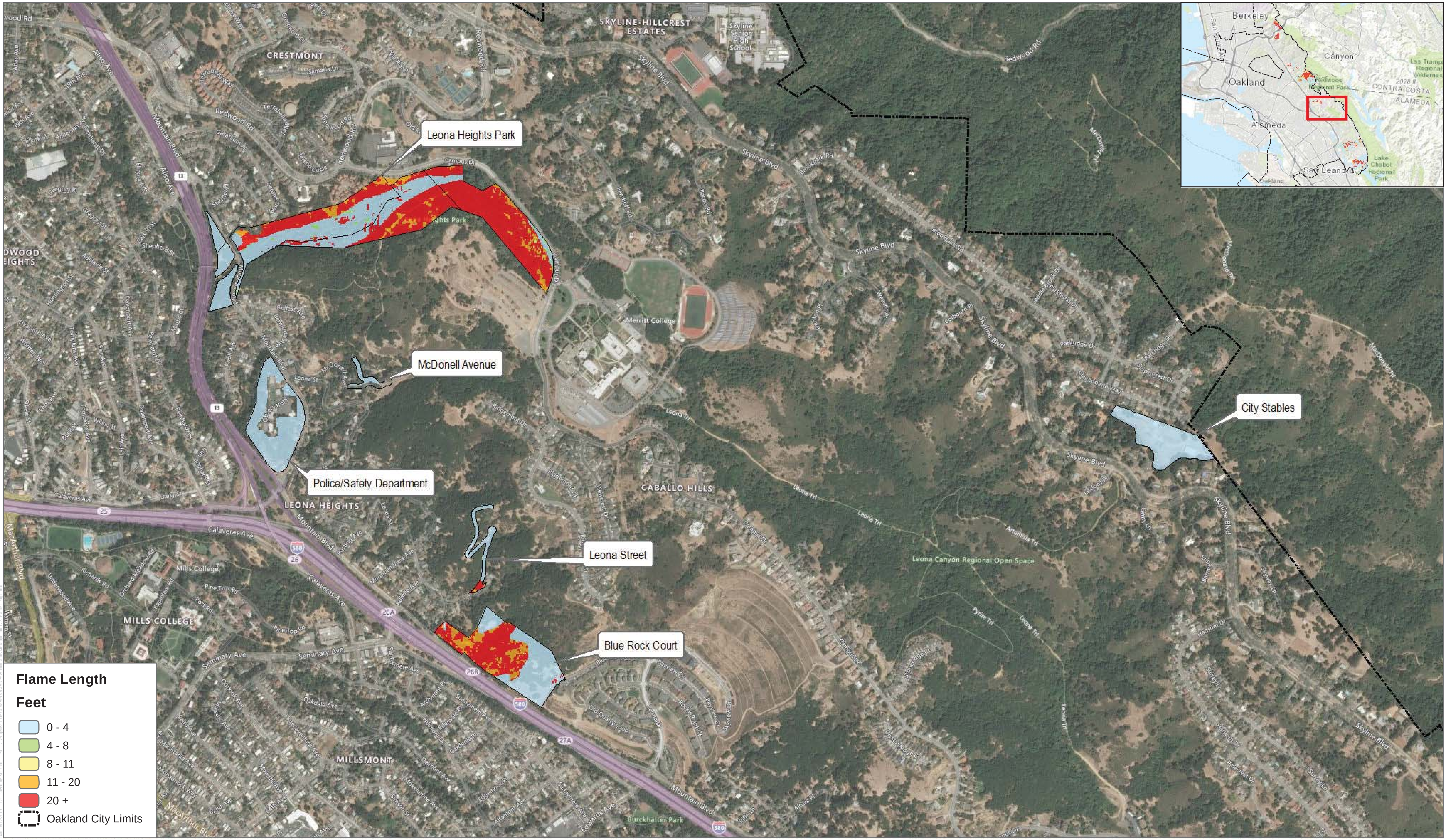
APPENDIX C-3

Fire Behavior (Flame Length)



SOURCE: USGS 2017; ESRI 2017; Dudek 2017

DUDEK

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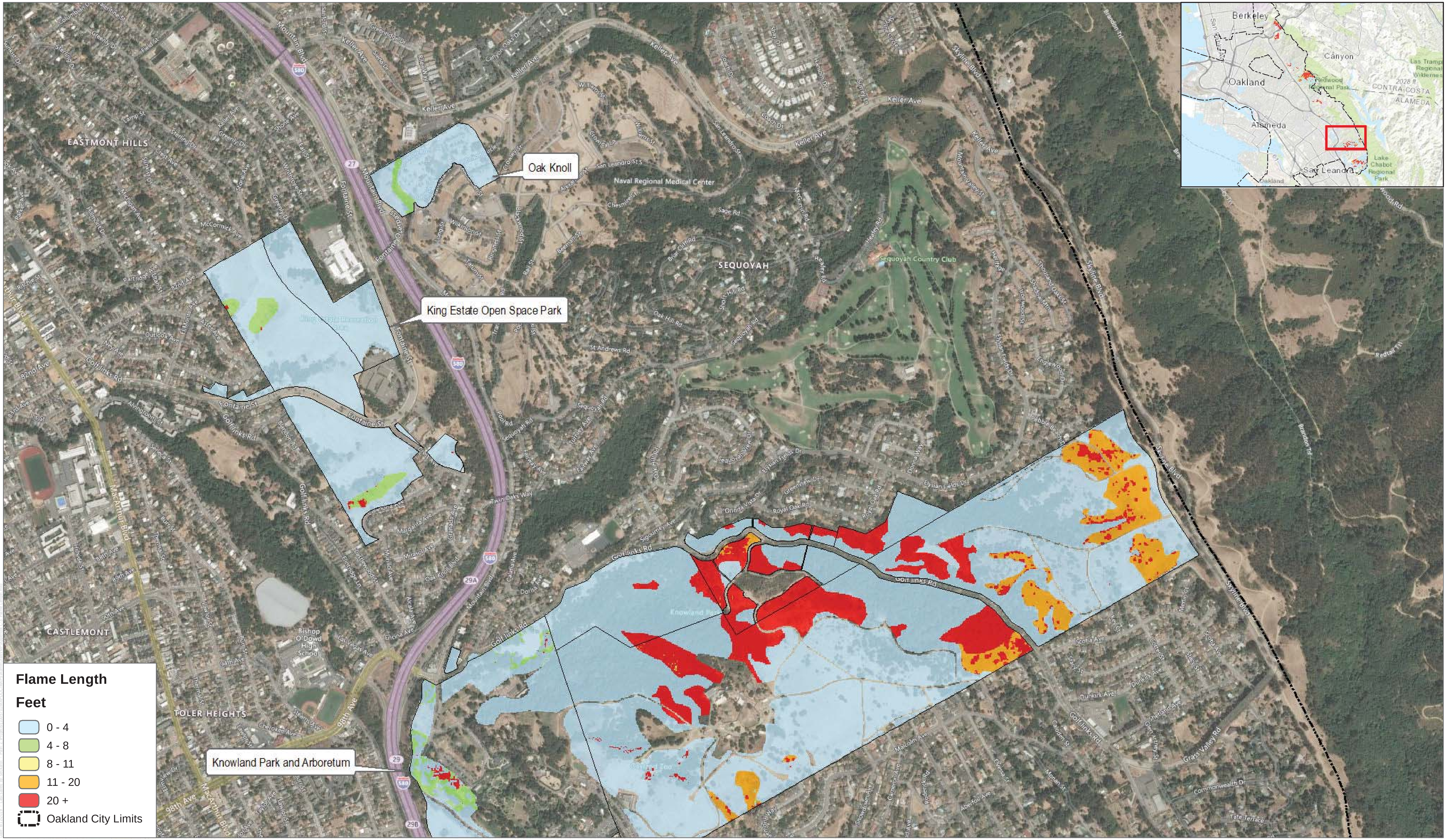
APPENDIX C-3

Fire Behavior (Flame Length)



SOURCE: USGS 2017; ESRI 2017; Dudek 2017

DUDEK

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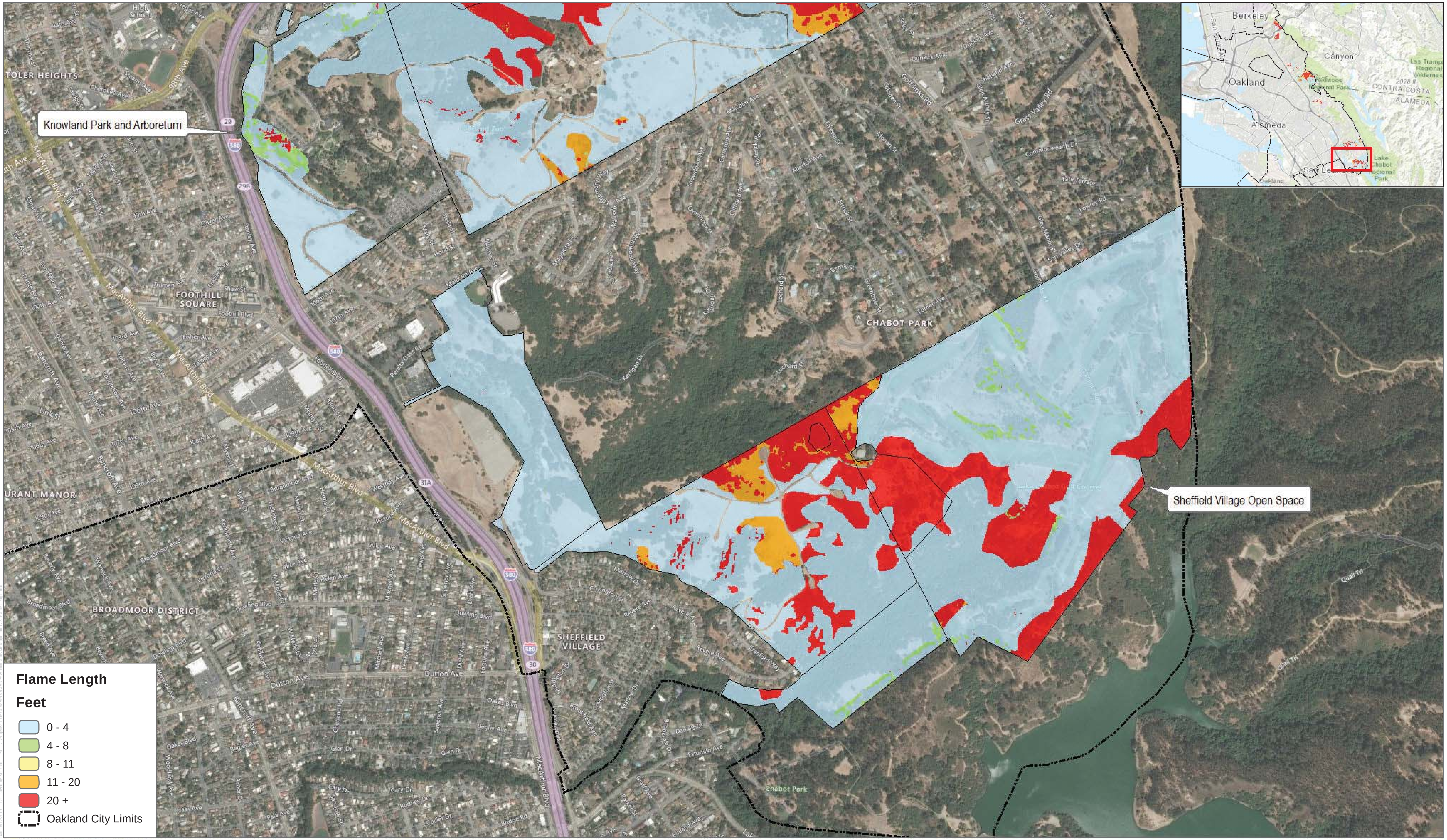
APPENDIX C-3

Fire Behavior (Flame Length)



SOURCE: USGS 2017; ESRI 2017; Dudek 2017

DUDEK

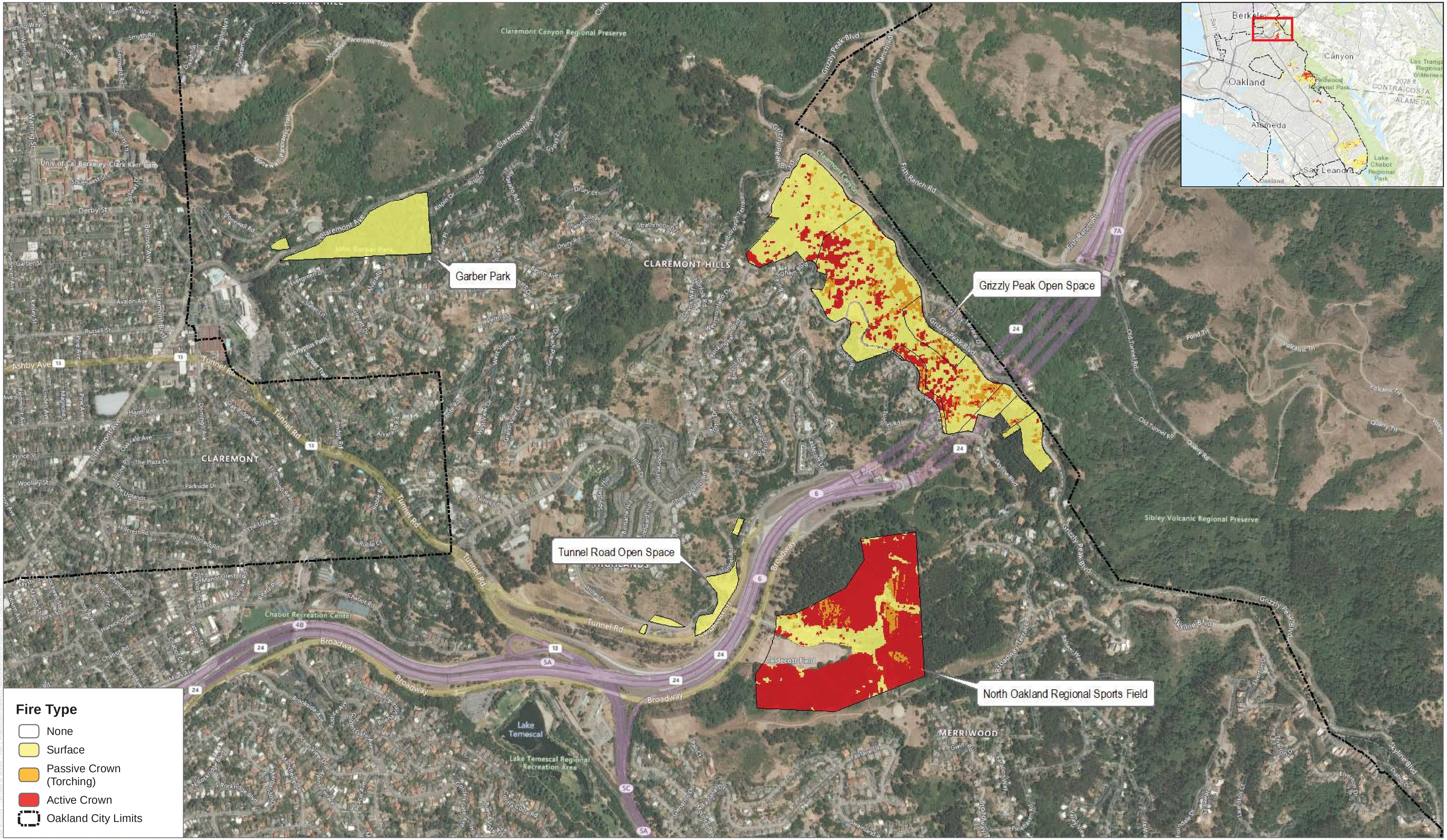
0 487.5 975 Feet

APPENDIX C-3

Fire Behavior (Flame Length)

APPENDIX C-4

Maps – Fire Behavior (Crown Fire Activity)

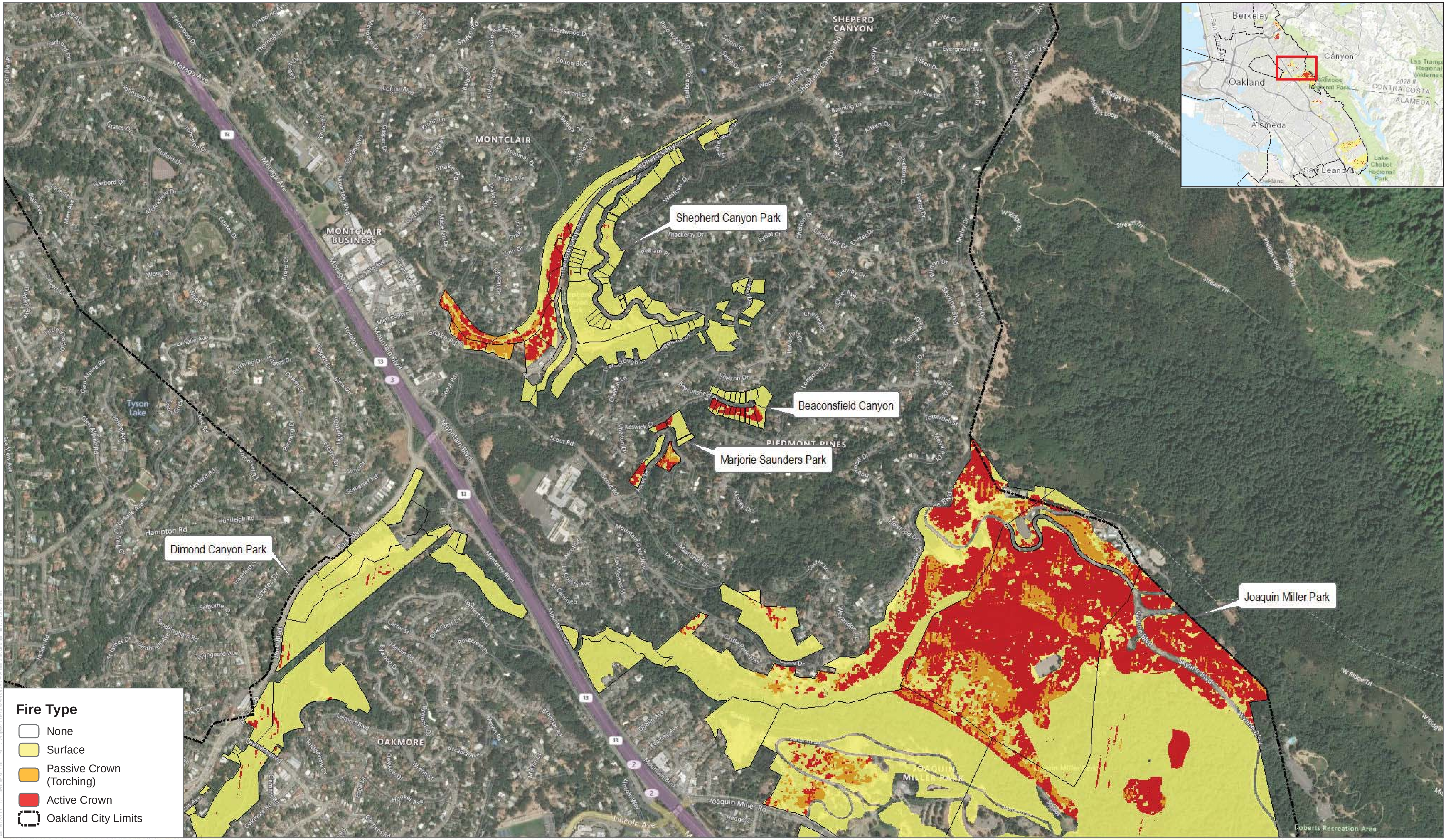


SOURCE: USGS 2017; ESRI 2017; Dudek 2017

DUDEK 0 487.5 975 Feet

APPENDIX C-4

Fire Behavior (Crown Fire Activity)



SOURCE: USGS 2017; ESRI 2017; Dudek 2017

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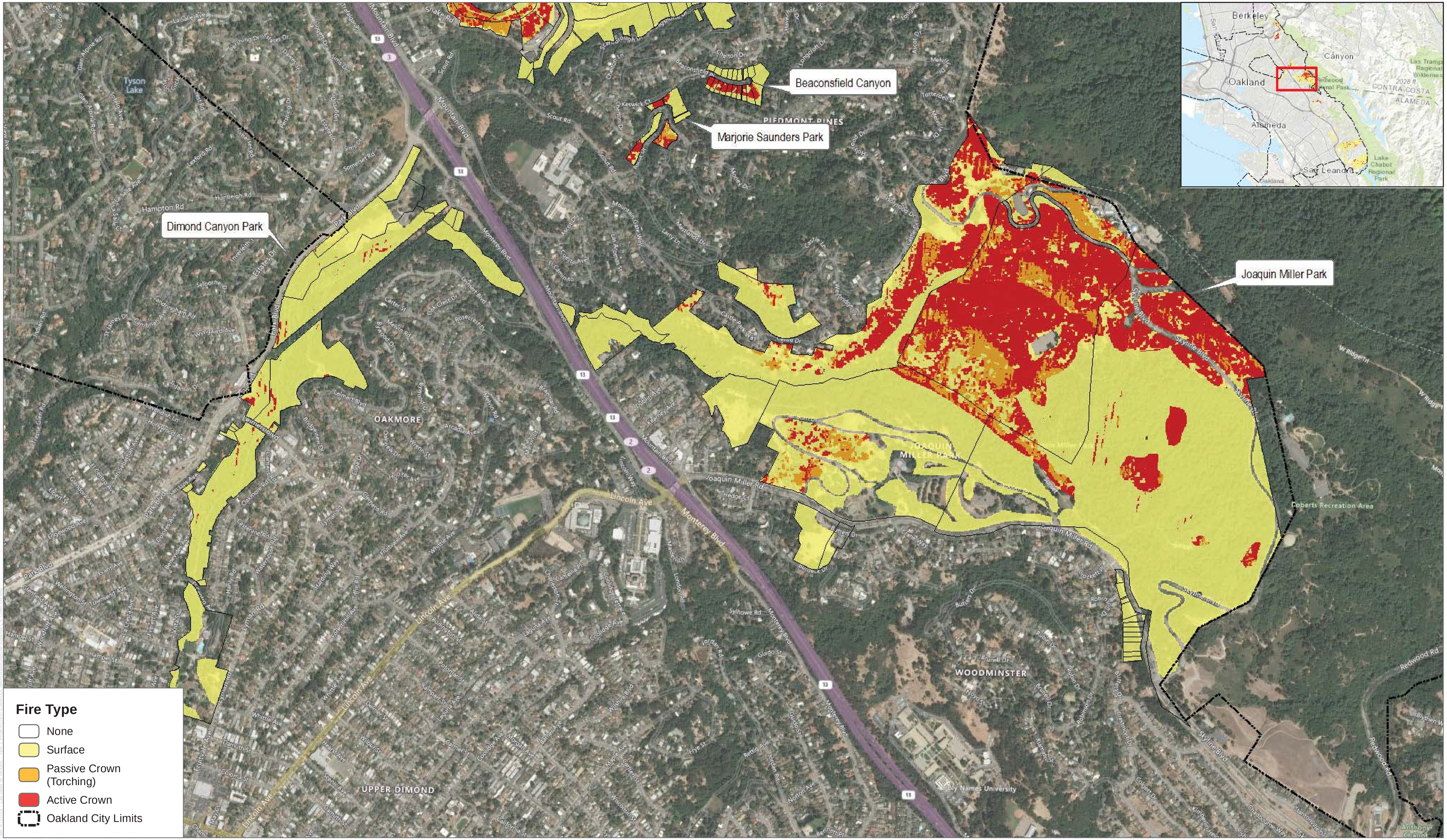
APPENDIX C-4

Fire Behavior (Crown Fire Activity)



SOURCE: USGS 2017; ESRI 2017; Dudek 2017

DUDEK

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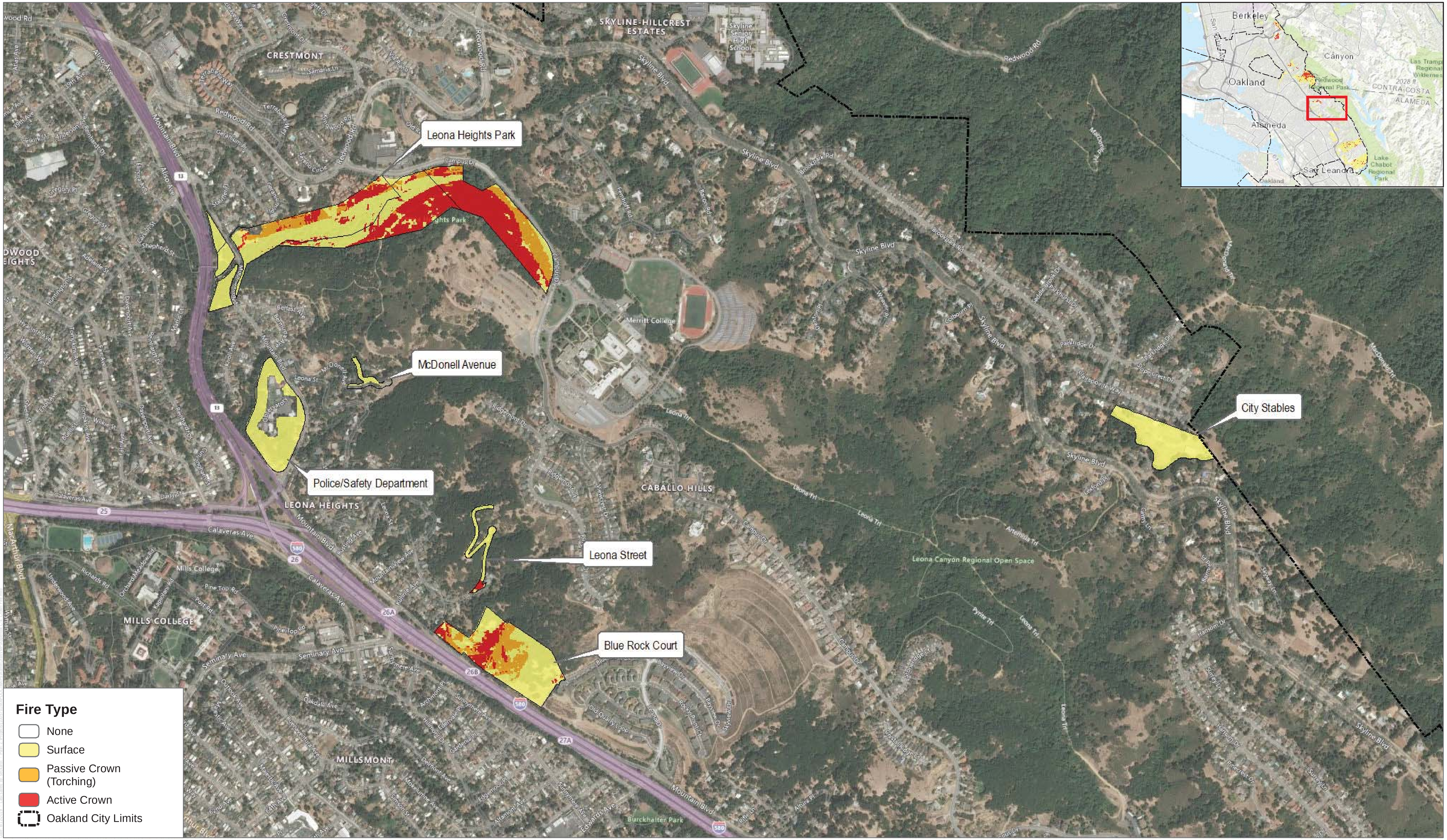
APPENDIX C-4

Fire Behavior (Crown Fire Activity)



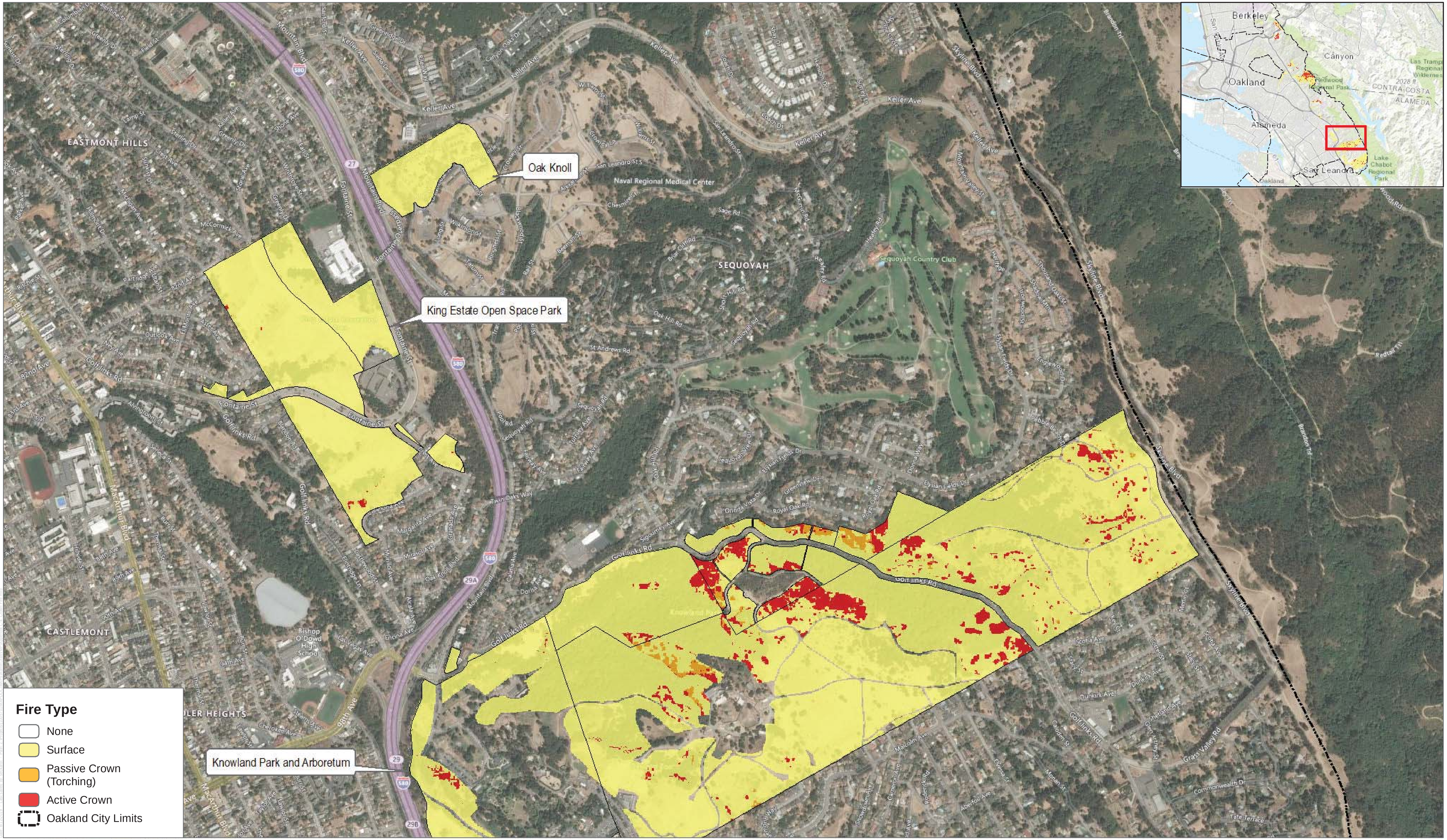
SOURCE: USGS 2017; ESRI 2017; Dudek 2017

DUDEK

0 487.5 975 Feet

APPENDIX C-4

Fire Behavior (Crown Fire Activity)



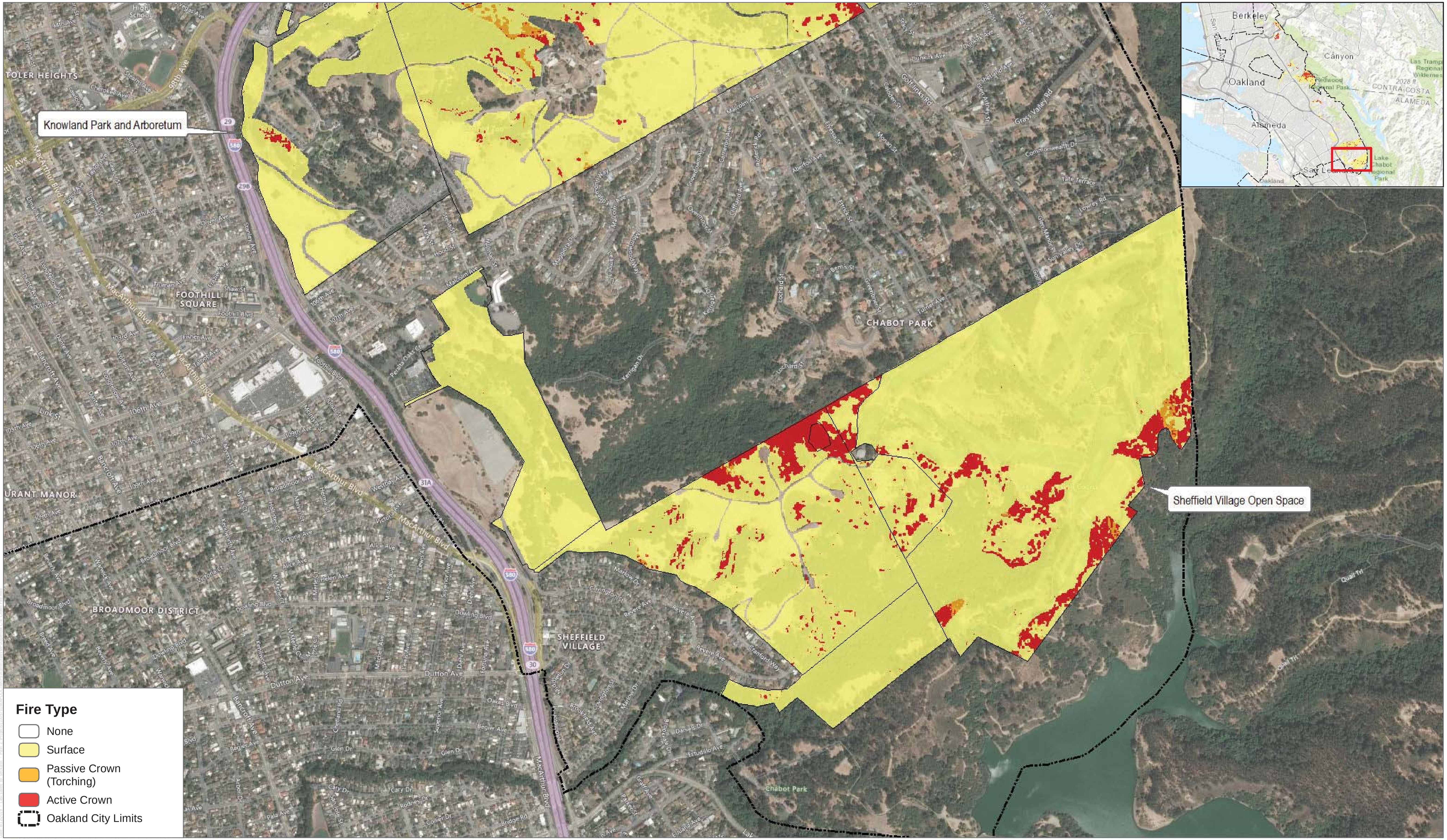
SOURCE: USGS 2017; ESRI 2017; Dudek 2017

DUDEK

0 487.5 975 Feet

APPENDIX C-4

Fire Behavior (Crown Fire Activity)



SOURCE: USGS 2017; ESRI 2017; Dudek 2017

DUDEK

0 487.5 975 Feet

APPENDIX C-4

Fire Behavior (Crown Fire Activity)

APPENDIX D

Highly Flammable and Invasive Plants

APPENDIX D
Highly Flammable and Invasive Plants

Trees		
Abies spp. (fir species)	*Eucalyptus spp.* (eucalyptus species)	*Schinus spp.* (pepper species)
Acacia spp. (acacia species)	*Ilex spp.* (holly species)	*Tamarix spp.* (tamarix species)
Ailanthus altissima (tree-of-heaven)	*Larix spp.* (larch species)	*Taxus spp.* (yew species)
Assorted palm species (palm species)	*Lithocarpus densiflora* (tanoak)	*Thuja spp.* (arborvitae species)
Cedrus spp. (cedar species)	*Maytenus boaria* (mayten)	*Toxodium spp.* (bald cypress)
Chamaecyparis spp. (false cypress)	*Picea spp.* (spruce species)	*Tsuga spp.* (hemlock species)
Crataegus monogyna (hawthorn)	*Pinus spp.* (pine species)	*Ulmus spp.* (elm species)
Cryptomaria japonica (Cryptomeria)	*Prunus spp.* (plum and cherry)	*Umbellularia californica* (California bay)
Cupressus spp. (cypress species)	*Pseudotsuga menziesii* (Douglas fir)	
Shrubs		
Adenostoma fasciculatum (chamise)	*Baccharis pilularis* (coyote brush)	*Erigonum spp.* (buckwheat species)
Adenostoma sparsifolium (redshanks)	*Castanopsis chrysophylla* (chinquapin)	*Tamarix spp.* (tamarix species)
Arctostaphylos spp. (manzanita species)	*Cotoneaster spp.* (cotoneaster species)	*Ulex europea* (gorse)
Artemisia californica (California sagebrush)	*Dodonaea viscosa* (hopseed bush)	
Ground Covers		
Baccharis spp. (Baccharis species)	*Hedera canariensis* (Algerian ivy)	*Juniperus spp.* (juniper species)
Perennials		
Bambusa spp. (bamboo species)	*Ehrharta spp.* (veldt grass)	*Pickeringia montana* (chaparral pea)
Carduus pycnocephalus (Italian bull thistle)	*Foeniculum vulgare* (fennel)	*Rosmarinus officinalis* (rosemary)
Centaurea solstitialis (yellow star thistle)	*Genista monspessulana* (French broom)	*Rubus spp.* (blackberry species)
Cortaderia jubata (jubata grass)	*Lonicera japonica* (Japanese honeysuckle)	*Salvia mellifera* (black sage)
Cortaderia selloana (pampas grass)	*Miscanthus spp.* (grasses)	*Spartium junceum* (Spanish broom)
Cytisus scoparius (Scotch broom)	*Muehlenbergia spp.* (deer grasses)	*Vaccinium* (huckleberry)
Delairea odorata (cape ivy)	*Pennisetum spp.* (fountain grass)	

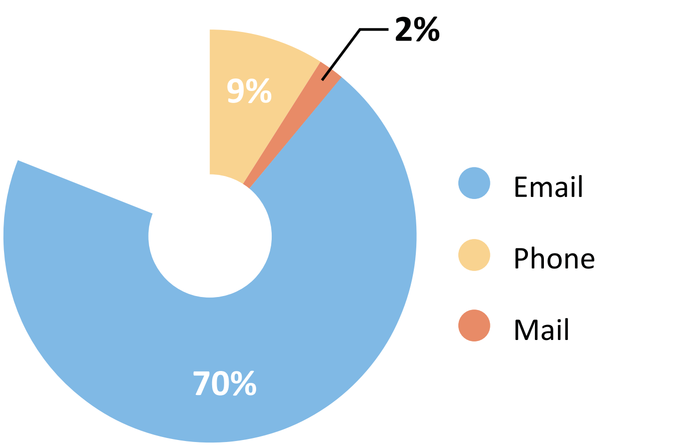
APPENDIX E

Summary of Public Engagement Survey Results

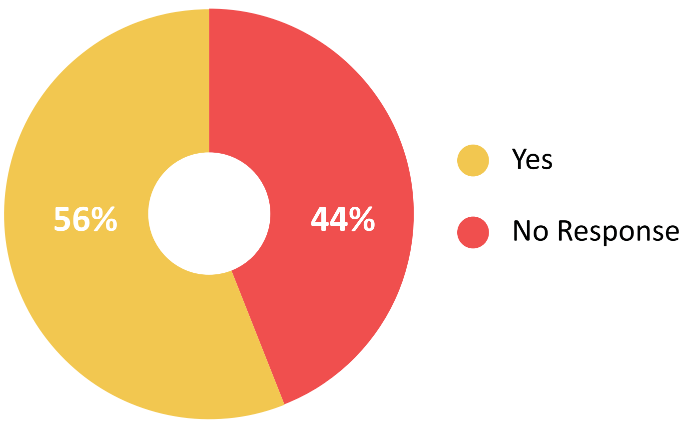
March-May 2017, Community Survey Results

Total Responses: 316
Total Unique/Individual Responses: 310

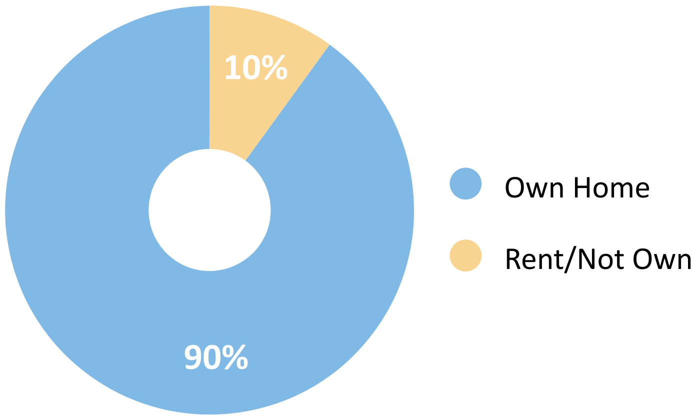
Preferred Method of Contact



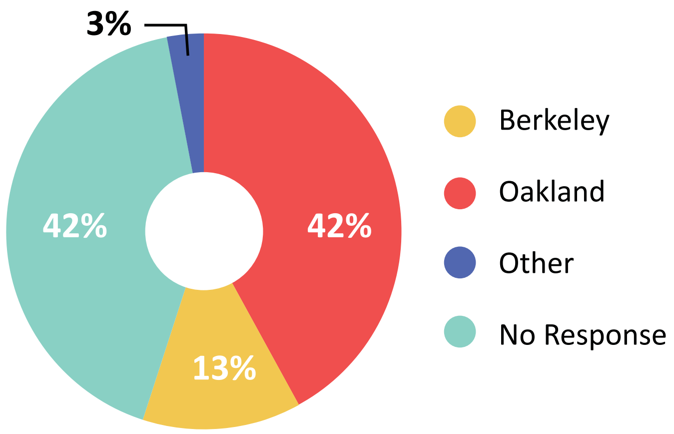
Add to Mailing List:



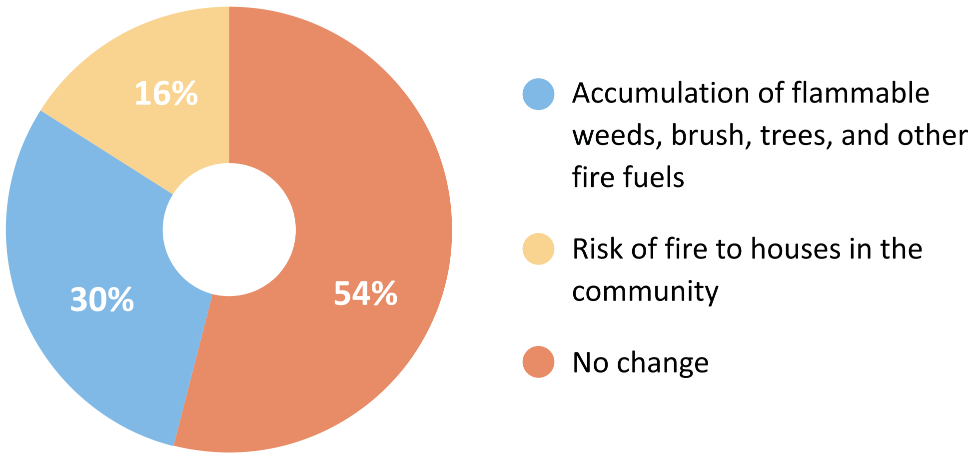
Home Ownership:



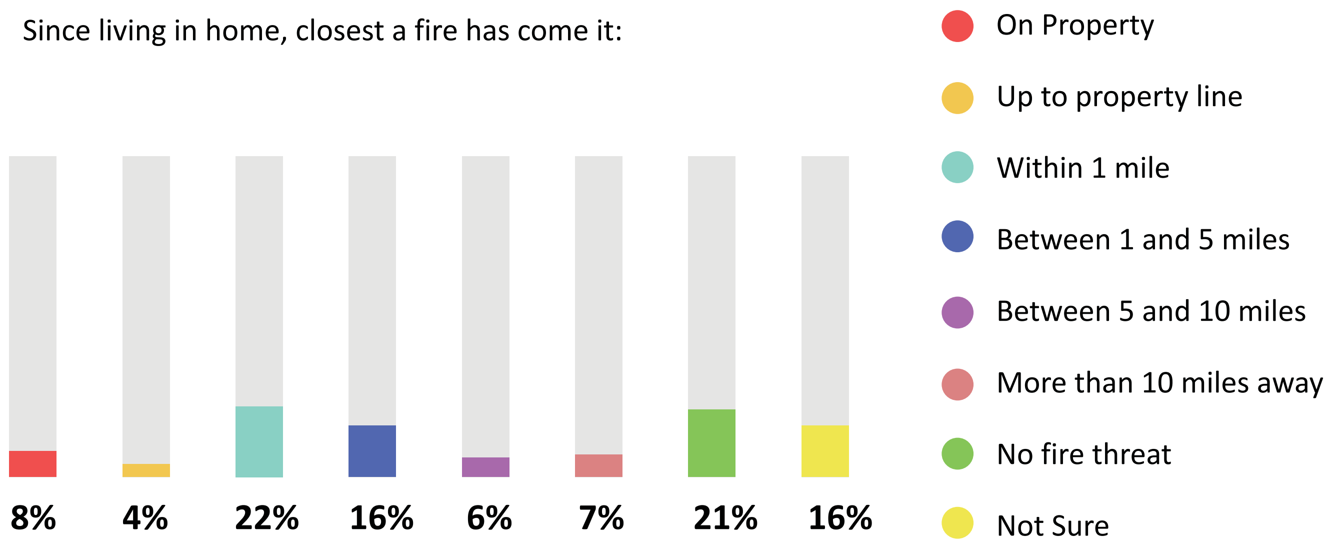
Percentage of respondents
from East Bay Hills:



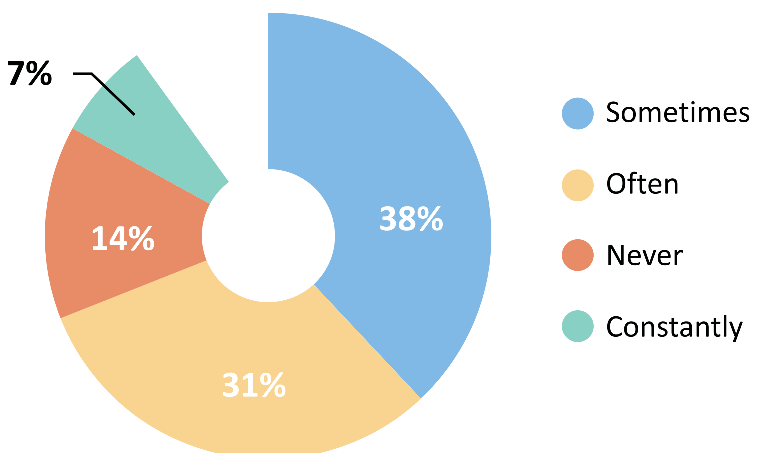
Since living in home, changes have been noticed in:



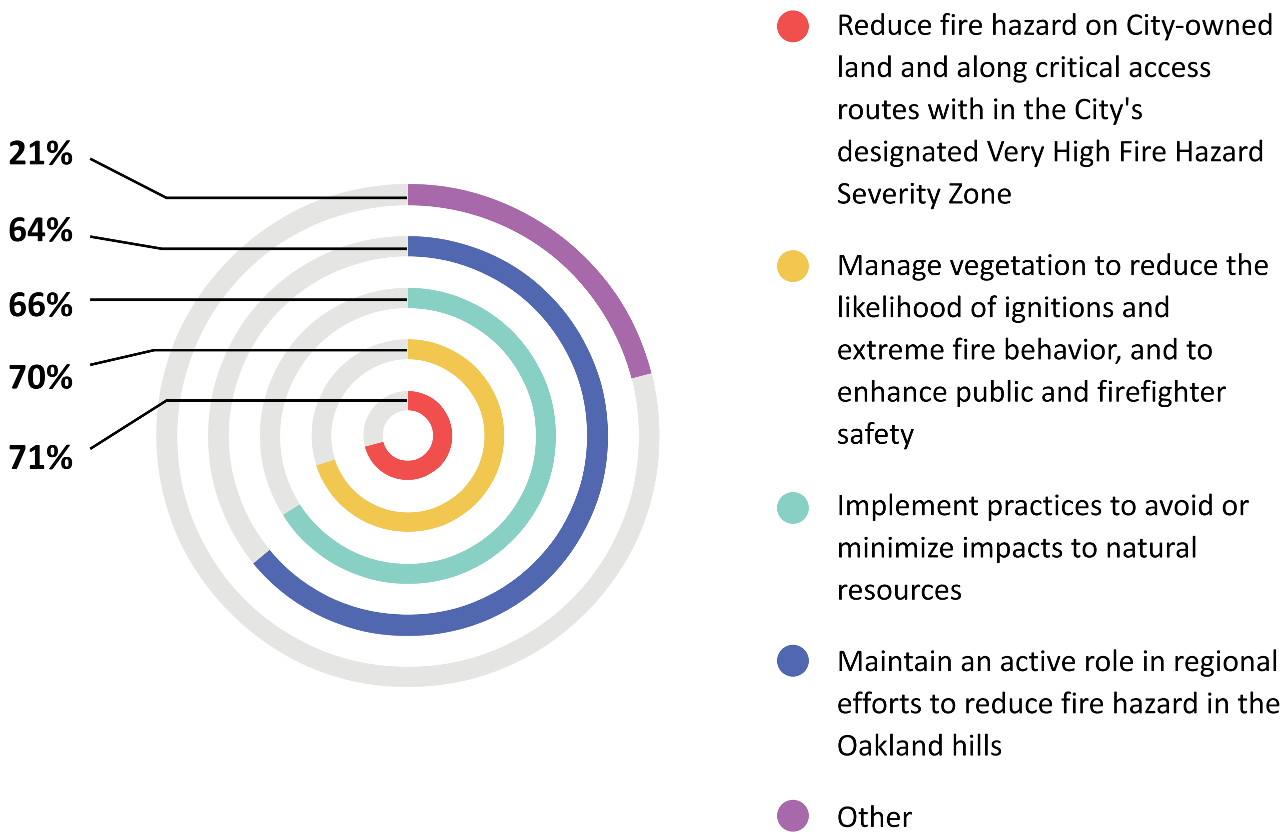
Since living in home, closest a fire has come it:



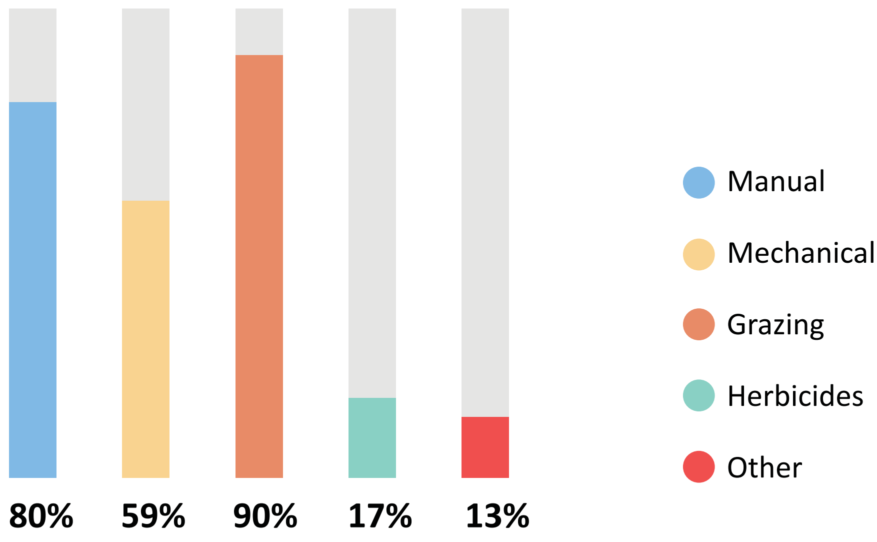
I worry about fire:



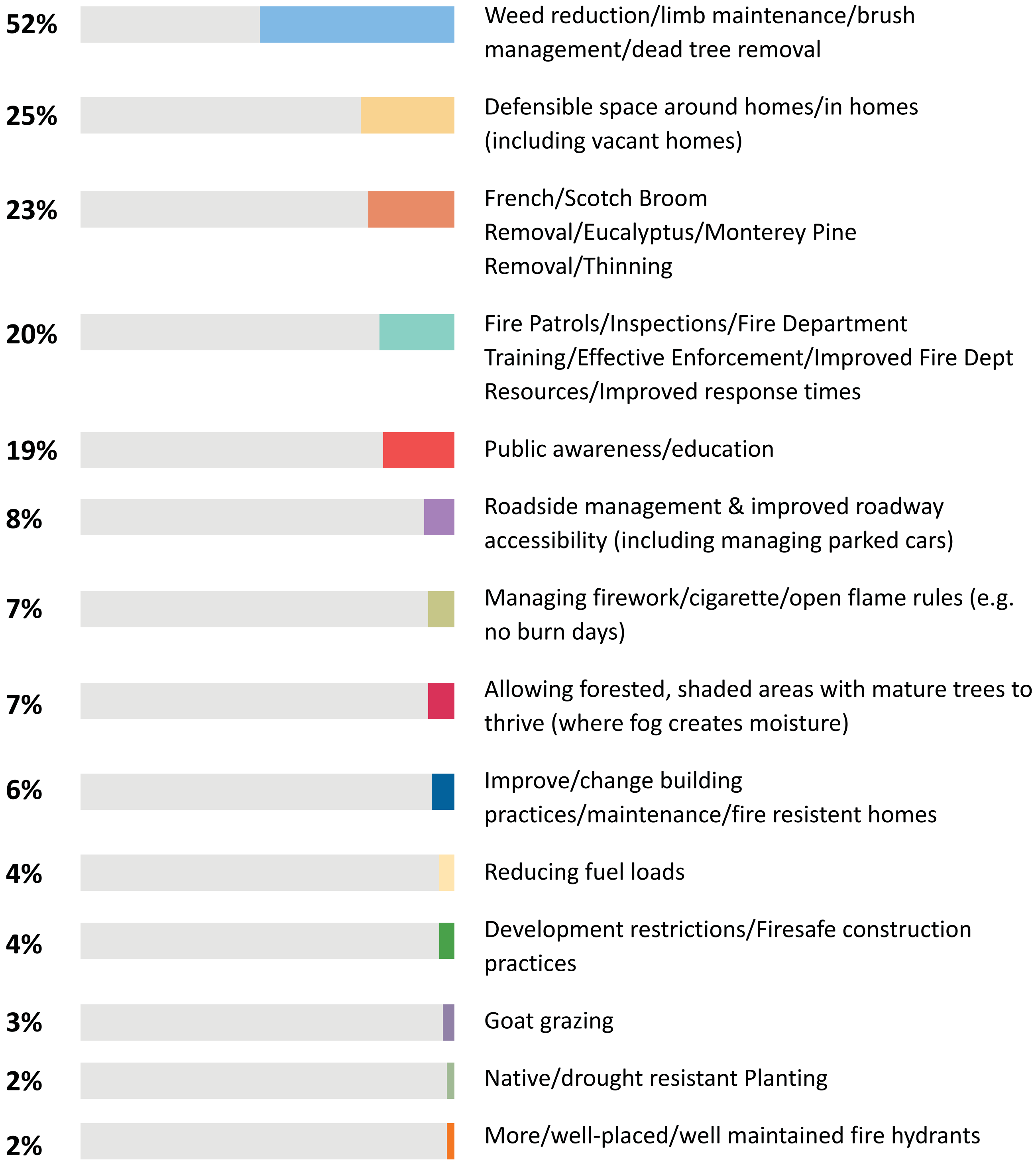
Goals to be included in the Vegetation Management Plan:



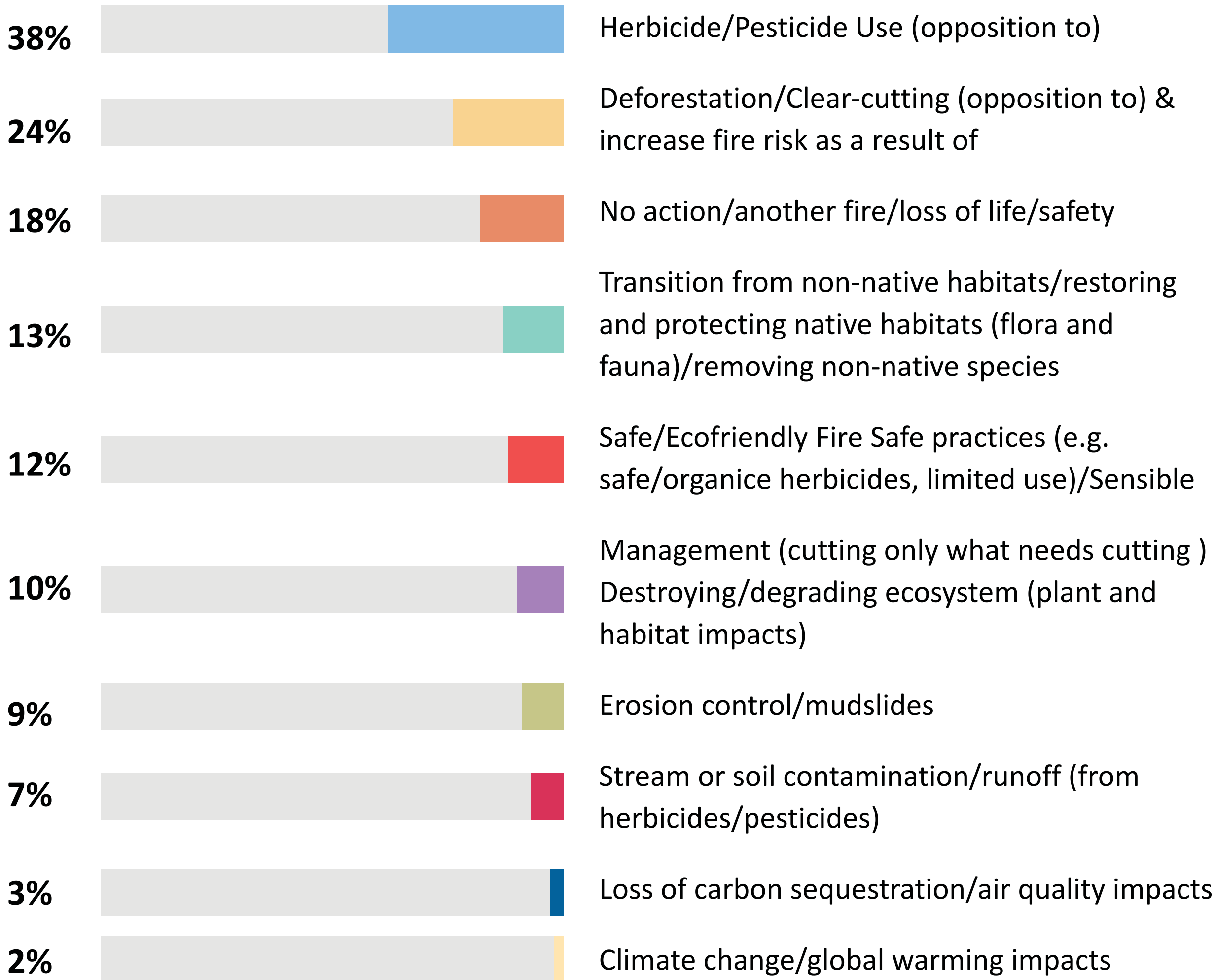
Preferred Vegetation Management Techniques:



In your community, what reduces wildfire risk?



Environmental Concerns:



APPENDIX F

The Weed Workers' Handbook - A Guide to Techniques for Removing Bay Area Invasive Plants

THE WEED WORKERS' HANDBOOK

A Guide to Techniques for Removing Bay Area Invasive Plants

The Watershed Project
California Invasive Plant Council

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Anouk Mackenzie (chapter 6 and resources)
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Berkeley, CA 94709
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"It's an amazing feeling of accomplishment when I visit some of our old sites. What had been a monoculture of an invasive species is being transformed by native plants taking the site back over, making it look like we had never been there."

Ken Moore, Wildlands Restoration Team, Santa Cruz

"When environmental restoration is most successful, it also improves our hearts, and cultivates an enduring relationship with Nature. . . . Done properly, environmental restoration restores far more than just the land."

Richard Nilsen, from Helping Nature Heal

"While we bemoan the lack of funding for our restoration work, it has an undeniable positive side: it forces us to rely on volunteers. How many of us have made exciting discoveries, gained insights into the world and into ourselves—learned things we didn't even know existed until they came into our consciousness? We who work in the difficult environment of fragmented, highly impacted natural systems in urban areas develop insights which may prove invaluable as the human societal and environmental crisis deepens. The knowledge gained from our experience may become in demand as awareness of the connection between human welfare and the natural world increases. Such knowledge cannot be found in our traditional repositories and disciplines. And, most surprising of all, we discover that when we understand how the world works we come to understand ourselves."

Jake Sigg, California Native Plant Society, Yerba Buena Chapter

CONTENTS

PREFACE

Welcome! The handbook you're holding contains vital information for restoring Bay Area wildlands. We hope it becomes a valuable tool for guiding your efforts in protecting local natural areas from the impacts of invasive plant species.

Most likely, you know from first-hand experience that invasive weeds are a serious ecological problem in the Bay Area. You may have witnessed grasslands overrun by yellow starthistle, or walked through an ivy-choked woodland. And, like many others, you are working to do something about it.

This handbook distills the collective knowledge of Bay Area individuals and organizations that have been involved in weed control and wildland restoration projects for over a decade. It provides background on the strategic planning that needs to happen before you actually remove any weeds, and offers detailed information on specific weeds and the techniques and tools best suited to working on them. The information in this handbook is intended to help us all conduct our weed control efforts more effectively.

Countless Bay Area volunteers and park managers have helped us learn about invasive plant control over the last decade. Many of them also contributed their time and expertise to this handbook—thanks to all.

If you have comments or suggestions for future editions, please let us know at www.cal-ipc.org.

We look forward to seeing you in the field!

Sharon Farrell, The Watershed Project
Doug Johnson, California Invasive Plant Council

1

BACKGROUND: PUTTING WEED WORK IN CONTEXT

Invasive species are one of the most serious environmental problems of the twenty-first century. They crowd out native species, disrupt natural processes, and impose tremendous costs on human communities. This is even more true for California than for most other states in the country. A few key facts illustrate the scope of the problem:

- Nearly half of the plants and animals listed as endangered species in the United States have been negatively affected by invasive species.
- Invasive species inflict an estimated $116 billion in economic damages annually in the United States and impose an additional $21 billion in control costs.
- Yellow starthistle has expanded its range in California at an exponential rate since mid-century. It now occupies 14 million acres of rangeland, more than 15 percent of the state's land area.
- Of the nearly 1,400 non-native plant species naturalized in California, at least 72 have significant ecological impact.

Scientists have been watching these problems get worse for several decades, but only in recent years has the matter received serious attention at national and international levels. In 1997, five hundred scientists and land managers wrote an open letter to then-Vice President Gore requesting action on invasive species. They declared, "We are losing the war against invasive exotic species, and their economic impacts are soaring. We simply cannot allow this unacceptable degradation of our Nation's public and agricultural lands to continue."

In response, President Clinton signed Executive Order 13112 in 1999. This established a National Invasive Species Council to coordinate federal activities and develop a National Invasive Species Management Plan. The council has since released a draft plan. The State of California is also working on its own plan, the California Noxious and Invasive Weed Action Plan.

But leadership is hardly limited to these formal institutions. In fact, such plans exist mainly because of a groundswell of public interest in invasive species and the damage they can cause. During the last decade, tens of thousands of Bay Area residents have dedicated at least part of a Saturday morning to removing weeds by hand. No matter what happens to the national and state plans, it's people like them—weed workers and land stewards, dedicated volunteers and hardworking professionals—who will have the greatest impact on the invasive species problem in our local parks and open space for some time to come.

This handbook arose in response to widespread interest among Bay Area weed workers for a compilation of information on the best tools and techniques for addressing the invasive plant problem in local parks and open space. (Throughout this handbook, we refer to parks and open space in a general sense, meaning any parcel of land, whether public or private, where invasive plants pose a problem to remnant wild ecosystems.) During our months working on this handbook, we spoke with several dozen weed workers, most of whom have more than ten years of experience with Bay Area weeds. We have sought to distill their expertise and experience and deliver it to you in a clear and straightforward way.

The primary audience for this handbook includes volunteers who are just getting into weed work, more seasoned volunteers who aim to start a weed program on their own, and interns and seasonal staff who work for the diverse agencies that manage public open space. But even long-time volunteers and professionals may find something useful in these pages.

This sense of the audience drove some of our decisions about what to include. Because of the heavy emphasis on volunteers and interns, we focused our review of tools and techniques on hand tools and manual removal techniques, although we do provide some information about power tools and herbicide treatments as well.

This chapter provides an overview of the invasive problem in the Bay Area and the various agencies and non-profit organizations that are key actors in the field. The second chapter provides strategic advice about setting priorities. If you can only remove a small portion of the weeds in a park, which ones do you work on, and where? Chapters 3 and 4 address some of the social dimensions of weed work: educating people about weeds and organizing volunteer work parties. The last two chapters are the heart of this handbook: chapter 5 contains a synopsis of the most useful tools and techniques used by Bay Area weed workers, and chapter 6 contains information on the control of thirty-six invasive plants found in the Bay Area.

WEEDS AND WEED WORK IN THE BAY AREA

Weeds have a long history in the Bay Area. Some may have arrived here as early as the middle of the eighteenth century, dispersing northward from European settlements in Baja California in advance of the arrival of the first Europeans in San Francisco Bay in 1769. The spread of invasive plants since then has been swift and steady. California's grasslands were the first to be transformed as invasive annual grasses from the Mediterranean quickly became dominant, helped by heavy overgrazing and droughts during the nineteenth century.

In the last few decades of the nineteenth century, land speculators planted tens of thousands of blue gum eucalyptus trees across California in an attempt to increase the value of their property for resale. Touting the silvicultural value of the trees, these speculators made profits while the unfortunate ones who purchased the land found that the trees were almost useless for lumber. Despite the mounting evidence, several more waves of eucalyptus plantings followed, finally stalling by the first part of the twentieth century.

This fervor for planting trees, stoked by the invention in Arbor Day in 1872 and the popularity of Frederick Law Olmsted's urban beautification movement, led to widespread plantings of many other tree species in the Bay Area, including some, like acacia and tree of heaven, that have since become invasive. Periwinkle and pampas grass were quite popular among gardeners in late nineteenth-century California, which explains their widespread distribution today.

Other invasives were never planted intentionally but spread into Bay Area wildlands once they had arrived in the area. Yellow starthistle, a native of southern Europe and western Eurasia, was first documented in Oakland in 1869. It probably arrived here by way of Chile, as a contaminant in imported bags of alfalfa seed. It spread quickly in the Bay Area and the Sacramento Valley and eventually throughout the state. In 1919 botanist Willis Jepson noted how quickly it had spread near his boyhood home of Vacaville: "It is 1,000 times as common as ten years ago, and perhaps even six years ago." Now that's a good argument for catching the next invasion early and preventing it from getting out of hand!

Public Agencies and Organizations

Open space protection also has a long history in the Bay Area, including such notable events as William Kent's donation of Muir Woods to the nation in 1907; East Bay voters taxing themselves in the middle of the Great Depression to purchase lands that became the heart of the East Bay Regional Park District; the innovative preservation efforts in Marin that led to the founding of Audubon Canyon Ranch and the Point Reyes National Seashore; and the parks-to-the-people movement of the late 1960s and early 1970s that led to the creation of the Golden Gate National Recreation Area (GGNRA) in San Francisco, Marin, and San Mateo counties.

This network of protected open space is governed by an alphabet soup of different public agencies, each with a mandate to protect the natural resources they contain. Since that often means controlling invasive plants, these agencies are often at the forefront of the struggle. These agencies include the National Park Service, the California Department of Parks and Recreation, the East Bay Regional Park District, the Midpeninsula Regional Open Space District, and many other city, county, and regional authorities that manage Bay Area wildlands.

In 2000, the State of California authorized funding to promote local coordination among weed workers in every California county. The legislation encouraged the formation of Weed Management Areas to receive the state funding. Most counties now have WMAs, and these groups provide a forum for public and private landowners and interested non-profit organizations to coordinate their land management efforts and to develop countywide strategies for controlling weeds.

Non-Profit Organizations

In 1965, a group of citizens in the East Bay organized a campaign to save an arboretum in Tilden Park, and the California Native Plant Society evolved out of that effort. CNPS is now the largest such society in the United States. Its members have long been concerned about the growing threat of invasive plants to the state's flora. In 1990, its Yerba Buena chapter began regular weeding work parties in San Francisco under the leadership of Jake Sigg, who also became active in statewide invasive plant issues.

Around the same time, the GGNRA's invasive plant program got off the ground with the formation of the Habitat Restoration Team under the leadership of Maria Alvarez (National Park Service) and Greg Archbald (Golden Gate National Parks Association—now the Golden Gate National Parks Conservancy). That effort gave rise to one of the nation's largest community-based stewardship programs, involving thousands of community members in weed work every year and training dozens of professional weed workers who now hold leadership positions throughout the Bay Area.

Also in the early 1990s, up in Davis, John Randall was developing what would become the Nature Conservancy's Wildland Invasive Species Program. And down in Santa Cruz, Ken Moore was leading the Wildlands Restoration Team in its efforts to address invasive plants in the Santa Cruz Mountains. As other groups began to join the struggle, it was clear that a critical mass was gathering.

In 1993, weed workers from around the state gathered to found Cal-EPPC, the California Exotic Pest Plant Council (now the California Invasive Plant Council). The organization patterned itself after the Florida EPPC, which was having considerable success bringing people together to strategize about invasive plants and develop better techniques for controlling them. Cal-IPC's annual symposium (held each October), newsletter, brochures, and Web site all aim to make information accessible to weed workers in the state. The group also coordinates efforts to assess which plants are invasive in California.

In a parallel development, public awareness and concern was beginning to grow about the state of San Francisco Bay and its natural resources. The Watershed Project (formerly the Aquatic Outreach Institute) formed to bring an educational message to the community—that our actions, whether through using pesticides in the garden, pouring oil down the storm drain, or allowing invasive plants to take over creeks and open space, affect the water quality of the Bay. The Watershed Project has helped support the steady growth of citizen involvement in creek groups, especially in the East Bay, where these groups are especially active in removing invasive plants. Through its workshops, newsletters, teacher training initiatives, and other outreach activities, Watershed Project staff members have taught thousands of students, teachers, and concerned citizens how to prevent pollution and protect and restore natural resources.

Today, these groups have partnered to produce this handbook. Drawing on the technical expertise of Cal-IPC members and the educational expertise of the Watershed Project, the handbook is aimed at increasing the effectiveness of Bay Area weed workers. The next episode of this story is yours to write!

2

STRATEGY: PLANNING FOR EFFECTIVENESS

Someone once described the spread of invasive plants as a "raging biological wildfire—out of control and spreading rapidly." It's an apt analogy. Invasive plants and wildfires can both inflict heavy economic and ecological damage. Much like wildfires, weed infestations can start small and then expand rapidly if not quickly controlled. And like wildfire management, effective weed management depends on four key strategies: prevention, early detection, control, and restoration.

We'll cover these four strategies a bit later, but first a question: Do those who fight wildfires try to get as much information about a fire before deciding how best to fight it? Of course they do, and they use maps to help organize that information. The same is true for weed workers. Knowing what's at stake—which invasive plants are threats and what they are threatening—is an essential step in developing an effective weed management strategy. Are there particular natural resources that are especially important to protect? Are there particular weeds that you know from reputation or personal experience could cause serious damage if they become established in your park? Which of the weeds in your park have the potential for rapid expansion and which have been there for decades without much change in the size of their populations? These are all geographical questions in the end, so it's only natural to use a map to organize the information.

MAPPING

Weed maps are great tools for prioritizing your work, monitoring your success, and creating a documentary record for those who will take your place in the future. A well-made map can also be an engaging outreach tool; like photographs, a single map can be worth a thousand words.

Mapping by hand is the simplest way to track weed infestations, rare plant populations, or other conservation targets. Select a base map—a USGS quad, a park trail map, or even an aerial photo—and then mark where particular weeds are found. Some weed workers make maps of particular invasive plant species on separate copies of the base map, one species per copy; others mark up a single copy. A map with just the right level of detail is what you're after, and that depends on your goals and aptitude. Map the type and size of the infestation using a standard set of symbols and indicate areas you have found to be weed-free. Also, of course, mark your conservation targets—the things you want to conserve.

It is also possible to map your weeds using a Geographic Information System (GIS) in combination with data collected in the field using a Global Positioning System (GPS) unit. This computer-intensive method is becoming the norm among professional weed managers, but many continue to rely on hand-drawn maps. For more information on both methods, refer to the California Department of Food and Agriculture's weed mapping handbook at cain.nbii.gov/weedhandbook.

PRIORITIZATION

Once you have identified your conservation targets and the weed infestations that threaten them, you can begin establishing some priorities. You may find that your first priority is to protect endangered species populations and other valuable areas, just like someone fighting a wildfire might seek to protect people and buildings. But that's not your only priority. You also want to contain the fire (stop the big infestations from expanding) while extinguishing spot fires that have jumped outside the perimeter (eliminating pioneer weed populations). You're looking for a balanced mix of the four main strategies mentioned earlier: prevention, early detection, control, and restoration.

PREVENTION

Preventing a new weed from becoming established in a park or open space is one of the best things you can do for the land. Weeds are so numerous in the Bay Area that it may be hard to imagine having to deal with new ones, but the distribution of weeds is always changing, due, in large part, to the activities of humans. You and your fellow outdoor enthusiasts may even be contributing to the spread of weed seeds from one local park to another. They can be dispersed by mountain bike tires, for example, or hiking boot treads.

If you want to prevent new invasions, think about how they might get there. If there are equestrian users in your park or open space, work with them to use certified weed-free hay for their animals. If there are neighboring properties that have an invasive weed that has not yet arrived on yours, then work with them to eliminate it on theirs, or at least prevent it from reproducing. If there is construction work, landscaping, or other management that might entail seeding or planting, make sure that they don't include invasive plants in their seed mix or planting palette. You'd be surprised how often this happens! Construction equipment itself is also a vector for moving weed seeds, so it's a good idea to keep an eye on the area over time.

EARLY DETECTION AND ERADICATION

Detecting new weeds and responding to them quickly is as important as prevention. It's almost certain that new weeds will arrive in your park. But the inevitability of arrival doesn't mean that they will persist. That's where you come in.

Containing a new weed, like containing an epidemic, depends on identifying it as soon as possible and initiating a rapid, coordinated response. Sounds challenging, but at a local scale it can be relatively straightforward. The main thing is to be attentive. If you see a plant that you've never seen before, try to find out what it is by asking an expert or keying it out (using the *Jepson Manual*, for instance). If it turns out to be an invasive plant and still occurs in relatively low numbers, try to eradicate the entire population.

Eradication means eliminating every single individual from the population, not just most of them. If you're diligent enough, and visit the site year after year to ensure that plants germinating from the seedbank are never able to set seed, you can be successful in eradicating the population. (Imagine if someone had done that with yellow starthistle back in the nineteenth century when it was first becoming established in California!)

The keys to eradication are detecting a new infestation early, responding quickly, and monitoring it carefully. An underlying assumption is that the invasive plant, once eradicated, is unlikely to reinvade. If it's likely to do so—for instance, if it occurs in great numbers on an adjacent property—then by all means try to keep it out of your park or open space, but it doesn't make sense to mount an all-out effort to eradicate every last individual. The probability of reinvasion is too high.

It's hard to overemphasize the importance of detection. New weed populations can't be eradicated if they're not detected! The good news is that it gives you an excuse to spend time hiking around your favorite place. Many weed workers make a habit of walking every trail in the park at least once or twice a year to increase their likelihood of detecting any new weed populations. Some agencies have even instituted invasive plant patrols made up of volunteers who systematically search trails and other likely places for weed populations.

All this work is really worth it. As two veteran weed workers put it, "preventing or stopping just one new invasive weed would be of greater conservation benefit in the long run than far more costly and difficult efforts to control an already widespread pest."

CONTROL

When a particular weed has become widespread—like wild oats in a park with extensive annual grasslands—eradication is often no longer a sensible strategy. Instead, the most effective action may be to control its spread or lessen its impacts. Your park or open space may have, in addition to grasslands dominated by annual grasses, serpentine prairies where wild oats are just getting established. Though it may be well beyond your ability to eradicate wild oats from the entire park, you might more easily limit its spread into the serpentine prairies.

This example illustrates why focusing on outlier populations—small patches of a weed in an area that is otherwise relatively free of it—is often much more important than focusing on large, dense patches of that weed. It's easy to feel compelled to throw all your effort into working on a major infestation. But that's like sending fire fighters into the middle of a huge wildfire while ignoring its perimeter. It keeps on spreading, as if you hadn't done a thing.

A strategy of containment may be your best option for invasive plants like Cape ivy or blue gum eucalyptus, which would require huge amounts of labor to fully eradicate and whose spread is mostly limited to areas in the immediate vicinity. For such plants, it's better to focus on containing the large infestations and eliminating all the outlier populations than to spend countless hours trying to eradicate the main populations. Containment works well with infestations of these two plants because their pattern is to expand outward from the edge of the infestation, Cape ivy with advancing vines, and blue gum eucalyptus with new seedlings. (Eucalyptus seeds don't tend to disperse very far.) Cleared areas around a patch of Cape ivy—containment paths—allow weed workers to easily patrol for new vines. Plants that disperse their seeds more widely, such as jubata grass, are not as effectively controlled using containment.

Once you've tackled an outlier population and removed all the plants you can find, keep track of its location—preferably on a map—and take notes on your effort. You are working against not only the plants you see in front of you, but also the weed seeds in the soil. They can last a long time in the seedbank, for many decades in the case of French broom, or just a few years in the case of small-seeded plants like pampas grass. Once you've decided to eliminate that outlier population, it's important to return every winter or spring until no more seeds are germinating. Maps and good record-keeping will help you be persistent.

Except in really small parks, it is nearly impossible to keep track of all the sites where you have removed weeds unless you keep written records. Since every site where you have removed weeds needs to be revisited, you will come to rely on your records to make sure that you do. Develop a simple form for tracking the what, where, when, why, and who of work performed.

Conservation targets, maps, outliers, containment, and persistence—these basic ideas will stand you in good stead as you decide how to focus your weed efforts. The aim of control is not to eradicate weeds, but to reduce weed density and abundance below an acceptable threshold. The methods for both eradcation and control are similar and include a wide variety of techniques that are treated at much greater length in chapter 5.

> "It's invaluable to have intimate on-the-ground experience with the land. Where you're working with the same piece of land, where you see the changes, season by season, year after year, you're making acute observations about the dynamics going on, and that is what is in such short supply. If you don't know the actual on-the-ground situation, then anything you do as a manager is going to be somewhat off."
>
> *Jake Sigg, California Native Plant Society, San Francisco*

RESTORATION

Weed removal is ultimately about returning the native plant community to the area. Once we have removed the weeds, there are often native seeds in the soil that helps restore native vegetation. But in other cases, if the native seedbank has been exhausted, revegetation—that is, replanting with natives—might be necessary after weed removal. This handbook does not cover revegetation, but here are a few tips to keep in mind. In heavily impacted areas, it may be necessary to partner with a native plant nursery that can propagate seedlings from locally gathered seed. When describing your project to others, make sure to communicate the role of weed removal in the greater picture of restoration. This is especially important when you are working on large areas that are in the public eye.

WEED WORK IN PRACTICE: ADAPTIVE MANAGEMENT

Translating these key strategies into action will keep you busy. Learning from your initial actions, so that your next set of actions is more effective, will keep you smart. It's common sense really—start with a plan, carry it out, check to see if it worked, adjust accordingly, and carry on.

Conservation practitioners have formalized this common sense approach into what they call *adaptive management*. We always have the potential to learn something from our management actions—but only if we monitor and assess the impact of those actions. For weed workers, this can mean something as simple as visiting an outlier population a year after removing all the above-ground individuals. If there are seedlings coming up, then we need to do something we didn't have to do last year: treat seedlings, not big plants. This might call for a different control technique, one more suitable for seedlings.

Monitoring is the key. Without some kind of monitoring, there is essentially no way that you can succeed. The seedbank will always work against you. But monitoring doesn't have to be painful and involve lots of data collection and analysis. The simple steps of keeping good records and visiting all your sites repeatedly go a long way.

3

COMMUNICATION: TALKING ABOUT WILDLAND WEEDS

Reaching out to all kinds of people is one of the best things you can do for the long-term health of your favorite park. Talking to passers-by while you're working can be even more important than getting the work done. Doing so can lead to a big donation to your cause or even turn angry adversaries into awesome advocates.

Such outreach can have ripple effects that extend far beyond the park's borders. When enough people understand the impacts that invasive plants can have on the landscape, they will avoid planting them in their gardens and become more likely to support stewardship efforts at the ballot box by voting for local parks and open space measures.

Some people are blessed with the ability to communicate complicated ideas quickly and effectively. These natural communicators make it look effortless in a way that can be intimidating for the rest of us. But we're not doomed to being tongue-tied. This chapter provides some simple techniques that will help you convey important messages about wildland weeds to diverse audiences.

THE ABCs OF INTERPRETATION

You are engaged in the art of interpretation whenever you are talking with park visitors along a trail or to a group of volunteers at a work party. This word came into widespread use among park rangers during the last half-century to distinguish between mere instruction and information on one side and provocation and revelation on the other. The National Association for Interpretation defines interpretation as "a communication process that forges emotional and intellectual connections between the interests of the audience and the meanings inherent in the resource."

Interpretation is an art rather than a science because it requires you to re-create all the information that you have learned—the number of weeds in the park, their names, what plants they're crowding out, all the stories you've heard about invasive plants worldwide—in a way that's accessible, meaningful, and compelling to your audience. Since it took you months and years to learn all those things, it doesn't make sense to expect your audience to do so in just a few minutes. But that doesn't mean you can't convey complicated ideas. Follow these ABCs of interpretation, which come from a talented interpreter who has also led hundreds of work parties.

"When we encounter people on the trail, they'll ask, 'What are you doing?' They can even be a little bit confrontational. They just see green plants lying dead on the ground. We sit down and explain why we're doing this, and more often than not—probably 80 percent of the time—they turn around completely and say, 'You know, I've never thought of that. I've never thought that a plant could be a problem.' And sometimes people walking along the trail have said, 'You know, I'd like to write you a check right now, on the spot.' Even as much as $500!"

Ken Moore, Wildlands Restoration Team, Santa Cruz

Know your Audience. If you can connect what you have to say to something in your audience's experience, your message is much more likely to be remembered. Don't assume that they know how pervasive the problem of invasive plants is, or how it affects the beauty of this special place. Build connections with them by using photographs (before-and-after photos of your site) and visual cues (point out a plant in flower that you're trying to protect). Engage as many senses as possible. Crush a yerba buena leaf, for example, and invite them to smell the delicious scent and then tell them how it's threatened by ivy. Have fun with those common names. Why is it "sticky" monkeyflower? What about skunkweed? Should you make a coffeeberry brew?

Keep it Basic. Don't overwhelm your audience with information, even if it's a captive audience that has joined you for a work party. They came to work, not listen to you ramble on, and a person is only going to retain so much. Stick to the most important ideas. Don't worry, though, that your knowledge about the natural world will not be useful. It will serve you when the occasion presents itself—when you notice a rare migrant bird singing in a nearby thicket, or when you encounter an uncommon plant that has seeded itself into your worksite following weed removal, or when you respond to innocent questions about the name of that hawk with a red tail. Seize the teachable moment—but keep it only for that moment and then let it go!

Remember the Context. If a couple out on a walk stops to ask a simple question, respond with a simple answer, in a manner that encourages dialogue. Be respectful of the context and make it your goal simply to forge connections with others. Don't launch into a ten-minute lament about how invasive species are turning the planet into a single homogeneous biosphere. Develop an elevator version of your spiel: it should last no longer than an elevator ride and convey enough interesting information and inspiration that your listeners want to spend more time with you.

These principles apply not only to speaking but also to the printed word. Take advantage of opportunities to spread the word about your project. For instance, posting signs at your worksite with before-and-after photographs can serve as excellent advertising for your work.

TERMS

Part of the genius of the English language is its versatility and its remarkable abundance. Take *weeds,* for example, and the other words we use to describe them: invasive plants, alien plants, exotic plants, exotic pest plants, non-indigenous plants, non-native plants. The meanings overlap, but none are exact synonyms.

First, it is important to be accurate. Not all non-native plants are invasive, so these terms should not be used interchangeably. In fact, only a small percentage of non-native plants are widely naturalized in California's wildlands, and of these, only a few cause significant ecological damage—these are the invasive plants.

Second, it is important to use such terms with an appreciation for their cultural meanings. In a place with as much cultural diversity as the Bay Area, consider how your terms might be heard. You may use "non-native" in an innocent and descriptive manner, but it may carry other meanings for an audience of schoolchildren from immigrant families. This makes it doubly important to stress that it is not the non-native nature of the plants that present problems—there are many non-native plants that we love! But there are a few that can be quite destructive.

Familiar metaphors can help illustrate the point. A common one is that invasive plants act like bullies, taking over entire habitats. Another is that invasive plants act like a business monopoly that uses its market power to force other firms out of business and drive up prices. Like the anti-trust regulators who rein in monopolies, weed workers are helping to level the playing field for everyone.

Metaphors can be incredibly useful, but they can also oversimplify your message. Writers in the popular press often latch onto war metaphors to express a sense of drama. Weed workers are described as "weed warriors" battling an invading army of invasive plants marching through native plant territory. Such metaphors paint an antagonistic image of weed workers and do not capture the positive spirit or complexity of ecological restoration.

FREQUENTLY ASKED QUESTIONS ABOUT INVASIVE PLANTS

Here are some questions that you should be prepared to encounter when you work on invasive weeds, along with some general answers.

Does the park staff know you're doing this? Yes, they are quite supportive of this project. They are especially concerned about these weeds because they threaten some sensitive areas that they're trying to protect.

That plant is pretty, why are you removing it? Pretty, yes, but it can have harmful effects on our natural environment. Many other plants—and the animals that need them—are being crowded out by this plant species. Some invasive plants are easy to hate because they're ugly or prickly, but many are quite beautiful. In fact, many of these plants were brought here originally for use as ornamentals, without knowing that later they would become such problems.

Why are you cutting down trees? It's true that trees are beautiful and we tend to think of trees as good for the environment. We're definitely not removing all the trees. But these particular trees are taking over this area, destroying the vegetation that was here before and replacing it with a much less diverse plant community.

Are all weeds bad? Not all plants that we call *weeds* are a problem ecologically. Not all of the "weeds" that grow in your yard are a problem here in the park, although some are. But it's true that wildland weeds have a negative ecological effect. Plants are not inherently good or bad—remember, each of these weeds is native somewhere. Back there, it might even be threatened by invasive plants from somewhere else—perhaps even California! Some plants simply have the ability to do more damage than good in the natural environment in a particular place.

Since most of us humans are from somewhere else, does this mean we should be removed? Definitely not. We're working on plants, and in fact many non-native plants do just fine here. It is a very small percentage that actually take off in the landscape at the expense of many other organisms. This is typically because the climate suits it, and because native animals or insects don't eat the plant, giving it a competitive advantage over other plants. Weed work is about supporting natural diversity—removing these few problem species allows hundreds of others to flourish.

What will happen if we do nothing? Some of these invasive plant infestations have the potential to become a virtual monoculture, forming patches where almost no other plants grow. The diverse mix of plants and animals that were here before is then lost.

What will happen to the animals that are using those invasive plants? Usually, the animals are using invasive plants for food or shelter because the native plants that historically served that purpose are gone or greatly reduced. If we restore those plants as the invasives are removed, the animals can begin using the native plants again.

What will it look like when you're finished? At the very end, it will look beautiful, more like that area over there that hasn't been invaded. In the medium term, it might look rather bad, since we have to remove a bunch of plants.

Why is this area fenced off? Will it always be fenced? It's important that we protect the newly planted seedlings so they can get established. Once they are strong enough to stand up to deer browsing, foot traffic, and new weed seeds, the fences can come down.

How can I get involved? Glad you asked. We have materials right here with contact information to make it easy for you to get involved.

When confronted with questions like these, keep in mind that you often have only a minute or two to answer the question. Using the ABCs of interpretation—know your Audience, keep it Basic, remember the Context—will help you have a creative, constructive conversation. It's some of the most important work you'll do!

4

COORDINATION: ORGANIZING VOLUNTEER WEED PROJECTS

An increasing number of land managers throughout the Bay Area sponsor regular opportunities for volunteers to participate in weed control efforts. There are dozens of work parties happening every month in public parks and open space, along urban creeks, and even on private land. But there are also tens of thousands of acres that have not yet been adopted by a dedicated band of volunteer weed workers.

Before you go out and start ripping out Cape ivy, however, there are a few important things to think about. Do you have permission to work in the area of concern? Can you confidently recognize your target weed and not confuse it with a native plant? Are you versed in the potential risks of poison oak and wasps? Do you know how to run a work party for volunteers? You need to be able to answer these and other key questions before initiating an invasive weed program. In this chapter, we offer tips for those readers who want to organize their own weed projects.

WORK CLOSELY WITH THE LAND MANAGER

In this era of reduced budgets, our parks and open space can sometimes look and feel as if they have been forgotten by the agencies responsible for them. It's easy to feel indignant towards the land manager—how dare they let such a gem of open space go to ruin! Usually, though, park staff members are just as concerned as you are, but they don't have adequate resources to take care of everything. That's where you and your volunteers can have a huge impact. Your demonstrated commitment and helpful attitude—not to mention your on-the-ground success—can encourage upper-level managers to devote more attention (and maybe funding) to natural resource management.

Building a good relationship with park staff at the field level will help you in many ways. If they understand and support your work, they can give invaluable logistical assistance, from providing tools and garbage bags to helping publicize your workdays and hauling away your debris. Even if they are too pressed with other business to provide much assistance on the ground, their partnership is still essential, because removing weeds can sometimes be controversial. So make sure that the land manager knows exactly what you are doing and has given you permission to engage in particular land management activities. Public agencies hold parks in trust for the community at large, and they are responsible for the long-term stewardship of the land.

Here are a few tips for building a strong relationship with land managers.

Understand and appreciate the agency predicament. It doesn't help your cause to accuse an agency of being a poor manager that isn't doing its job. Acknowledge that times are tough, and that agency personnel don't have nearly enough resources to do all the work that needs doing. Understand that agencies are usually juggling complex issues like recreational use, grazing, fire control, and the like.

Ask the agency to assign a particular staff member as your liaison. This helps the continuity and clarity of communications. Your liaison can become your best advocate and ally if they know what you are doing. Communicate with your liaison regularly.

Ask for help from the agency when you need it. Park staff will have some resources that can help your work, and soliciting their active involvement helps build a partnership with the landowner. That's a much stronger position than being a lone operator.

Garner support for your work from all levels of management. Your relationship with an agency will be strongest if upper-level managers—particularly those who are elected or serve in supervisory positions—also understand and support your stewardship efforts. Let them know that you are a team player who truly wants to work with them.

Know and adhere to the agency's liability policies and permit requirements. Before you start volunteering—and especially before you start leading other volunteers—make sure that you understand the ins and outs of a particular agency's liability policies and permit requirements. These are not uniform across agencies. The National Park Service, for example, requires its volunteers to sign a form acknowledging that the park will cover any medical expenses, while other agencies take the opposite approach and require their volunteers to sign a liability release form.

Leave a paper trail to ensure accountability. Most agencies experience frequent turnover in field staff positions, so you may have to work with new people every year who are unfamiliar with your project and the history of your relationship with the agency. A paper trail can help bring them up to speed. In the unlikely event of conflict, you will feel much more comfortable if you have documented everything—permits, waivers, releases, date and time of work parties, maps and photographs demonstrating accomplishments, plans, and so on—in writing.

In dealing with the public or the media, identify yourself as a volunteer working on behalf of the agency. If you receive public recognition for your weed work, be sure to acknowledge the land manager. When working on public land, it's often important that people know that you are working with the consent of the public's representative, the agency that owns the land in question. It helps to wear a shirt, cap, or even a patch that identifies you as a volunteer working for the park or open space, especially when working in remote areas.

KNOW HOW TO DISTINGUISH AMONG THE INVASIVE WEEDS AND THE NATIVE PLANTS

Your knowledge of plants doesn't have to be perfect. There's not a single weed worker who isn't still learning. The best thing you can do is to get really good advice early in the process. Go on a walk with the local plant experts. Ask them what the worst weeds are. Ask them what other plants can be confused for that weed. When possible, visit proposed work sites with them and ask them to help you identify plants in the vicinity, particularly ones that you should be sure not to disturb (like rare ones).

As a leader, it's up to you to make sure your volunteers aren't removing the wrong thing. Your best strategy for working with volunteers may be to focus on just one or two weeds at a time that are easy to distinguish.

KNOW ALL ABOUT POISON OAK

It is especially important that you are good at identifying poison oak, which is common (and native) in many plant communities throughout the Bay Area. The consequences of exposure to poison oak can be severe. Roughly 10 percent of the population is extremely sensitive to poison oak and may require medical intervention (steroids or hospitalization) if their skin is exposed to it. Another 10 percent is apparently immune, but most of us exhibit a wide range of sensitivity to urushiol, the rash-causing compound found in poison oak leaves and twigs.

Many California residents can identify poison oak when its shiny and oily red or bright green leaves announce its presence. But when its deciduous leaves have fallen, or when it adopts one of its other forms—it can be a vine, a tree, or even an ankle-high shrub in grasslands—it can be hard to recognize. As a coordinator of volunteer work parties, you should become a practiced observer of its many forms.

Before selecting a work site, carefully scout the area for poison oak. If poison oak is common, the site may be unsuitable for a volunteer workday. If it is uncommon, flag the areas with poison oak and caution people to stay away from them. We recommend that you work only in areas where poison oak does not occur, unless you have an experienced team of folks who are used to working around poison oak. At the beginning of each workday make sure that every participant can recognize poison oak in its various forms and that they know how to stay out of it.

Sometimes, despite all precaution, volunteer leaders and their weed workers are exposed to poison oak. Here are some measures that you can take to minimize the impact of accidental exposure.

Wear long pants and long-sleeve shirts to limit direct exposure to the skin. If gloves have an elastic cuff, shirt sleeves can be tucked into the glove. Likewise, tucking pants into socks or boot tops can help limit contact.

Remove and wash clothing immediately after the event. This will prevent the oils from migrating to couches, clothes in the hamper, and other surprising locations. Clothing and gloves exposed to poison oak should be washed; cold water and regular detergent work just fine. Take caution with boots and tools, which can become vectors for spreading urushiol, poison oak's irritant.

Use a barrier lotion like Ivy Block to protect exposed skin, especially the gap between glove and sleeve.

Use an oil remover like Tecnu to wash skin immediately after potential exposure. Many weed workers find this to be effective in reducing the extent and intensity of poison oak rashes. It seems to be less effective when the urushiol has already permeated the skin after a long day in the field.

Take a cool shower with a non-moisturizing soap. Laundry detergent bar soap like Fels-Naptha also helps to remove urushiol from the skin. Hot water and moisturizing soaps open up the pores on your skin, making them even more receptive to urushiol, so stick with cold water and non-moisturizing soap at first.

If a rash has developed, there are ways to minimize its impacts. A new product called Zanfel is advertised as being able to remove urushiol after it has penetrated the skin and developed into a rash. It's expensive (nearly $40 for a one-ounce tube that's good for about fifteen treatments), but some urushiol-sensitive weed workers swear by it. For severe cases, consult a doctor, who may prescribe cortisone shots that reduce swelling. That's the only treatment available when the rash becomes systemic.

KNOW ABOUT POSSIBLE WASP DANGER

Some weed workers feel that wasps are an even more serious issue than poison oak. Unlike poison oak, wasps seldom provide any advance warning—their nests are much more difficult to spot than poison oak bushes. Encounters with wasps don't happen often, but they are worth mentioning during your safety talk at the beginning of every work party.

For most people, being stung by a wasp is a painful annoyance, but for others it can trigger a serious allergic reaction called anaphylaxis. Those with the most severe reactions require treatment within minutes in order to avoid anaphylactic shock. Such people often carry a portable device that administers epinephrine, the most common being the EpiPen. As a work party leader, you should make sure that your volunteers, particularly those with severe allergies, are familiar with the risks involved. (For legal reasons, you can't administer the EpiPen, otherwise it would be a good thing to carry with you in your emergency medical kit.)

If your group encounters a wasp nest, mark the surrounding area with caution tape to keep people away from it. If people get stung, you're better off bringing the work party to an end and getting them home (or to a hospital if the allergic reaction is really serious) as soon as possible. There's no sense in putting people at risk by trying to get a bit more work done.

KNOW ABOUT TOOL SAFETY

As a work party leader, you must not only know how to use every tool safely, but also how to instruct all your volunteers in their safe use. Treat the subject seriously and forthrightly at the beginning of the work party, demonstrate how to use the tool properly and safely so that everyone can see how it works, and also demonstrate unsafe practices as well. Remind people how to work with tools in a group setting—such things as carrying tools low, not on your shoulder, and maintaining a safe distance between yourself and other volunteers. If you're going to have your volunteers work with tools that require safety equipment, don't rely on them to bring safety gear. You should provide it yourself and require them to use it. This includes having leather gloves for volunteers working with sharp tools like pruners or loppers.

Be prepared for minor injuries by carrying with you, to every work party, a full first-aid kit and a cell phone. If cell phone reception is not good at your worksite, know where the closest phone is and how to reach park rangers and other emergency personnel. Some weed workers who regularly lead work parties have chosen to take CPR and EMT training courses so that they are even better prepared in the event of an emergency.

CALL IT A WORK PARTY! FACILITATING COMMUNITY PARTICIPATION

Who knew that there would be so many things to think about when working on weeds! So take a deep breath and say, "I'm a volunteer. I'm interested in doing this because I love this place and I love being outdoors." You don't have to obtain degrees in botany, interpretation, volunteer management, and medicine in order to make a difference.

It's helpful to know your limits. If you're a volunteer just getting started, don't try to take on too much. In our experience, coordinating anything more frequent than a monthly work party is too much for most volunteers. Only paid coordinators, or those rare volunteers who have fifteen to twenty hours a week to dedicate to stewardship, are able to handle the complex logistical details associated with more frequent work parties or with organizing dedicated work parties for school or corporate groups.

Assuming, then, that you know the limits of your ambition, here are a few tips about running successful work parties. One golden rule: long-term sustainability depends on short-term enjoyment. If it ain't fun, it ain't going to last. Work parties can involve challenging labor, but volunteers won't return if they don't get something positive and meaningful out of it. A few volunteers are drawn to weed work primarily for the exhausting physical labor, but they won't give you a broad base from which to grow. Reaching out to all kinds of people and accommodating their diverse needs and interests—even if you don't achieve quite as much on any given work day—is often critical to the long-term success of a weed program.

Below is a listing of the tasks to do before, during, and after a work party. The list will help you plan your own event. And here are several key things to remember for improving your success in attracting and sustaining a dedicated group of volunteers: first, maintain your enthusiasm! Nothing kills the spirit of a work party like a leader who isn't enjoying herself. Second, identify tasks that can be achieved during a single work party—"Let's remove every broom plant between here and that tree today." And finally, offer a range of tasks that will provide variety for returning volunteers—"Who wants to pull broom? Who wants to collect native grass seed?"

Before the Day of the Work Party

- Coordinate everything with your park liaison.
- Scout the work site carefully, paying particular attention to poison oak and where the closest bathrooms are.
- Take "before" photographs while you're there.
- Borrow sufficient tools and gloves, and get a first-aid kit from the park or other sources.
- Develop an elevator talk that succinctly introduces yourself and the project to workday participants.
- Advertise the workday in appropriate venues (posting flyers, placing articles in the local community newspaper, etc.).
- Be realistic about the duration of the event. Don't try to fit too much in. In our experience, the ideal work day lasts two to three hours (10:00-12:30, for example) with a break in the middle or toward the end for goodies. Weekend mornings are best, particularly Saturdays.
- Arrange for donated goodies (or purchase them).
- See if others will help you lead the event; review with them the goals and tasks for the work party.
- Identify extra work in case too many people show up for the work party (this can actually happen!).

On the Day of the Work Party

- Arrive early, and be friendly and welcoming, particularly with people you haven't met before.
- Have attendees sign liability forms and waivers while waiting for the group to assemble.
- Pass a sign-in sheet so you have everyone's contact info for future work parties.
- Deliver your elevator talk and go over workday logistics (timing, tasks, poison oak, tool safety, bathroom location).

- Ask knowledgeable weed workers to team up with new volunteers or to circulate and make sure everyone is getting started.
- Seize teachable moments (with your workers or members of the public) that illustrate why we're engaged in this work.
- Take "during" photographs.
- Take a break for goodies!
- Quit working, gather up tools, and return to initial assembly site (parking lot, for example). Make sure that all tools and volunteers are accounted for.
- Thank everyone for coming and let them know how important their help is—and how welcome it would be in the future.
- Write some notes about who attended the work party, what was accomplished (number of person-hours, area of particular weed removed).
- Assess the work party itself: what worked, what could be improved, what follow-up is required with any of the volunteers.

After the Work Party

- Return tools.
- Report back to your park liaison.
- Take "after" photographs.
- Post signs at the work site if it's highly visible.

Ways to Improve Community Participation in Volunteer Work Parties

- Have a consistent schedule (e.g., 10:00 A.M. on the first Saturday of every month).
- Use dramatic before-and-after photographs to demonstrate the impact of volunteer labor.
- Print and distribute flyers for your monthly work party.
- Produce a calendar of upcoming work parties and post it in appropriate newsletters, list serves, and Web sites.
- Offer other educational opportunities to your volunteers (field trips, walks with experts).
- Cultivate fellow volunteer leaders who can help lead work days in your absence.

- Develop a Web site for your project and keep it up to date.
- Have a presence at appropriate community events (e.g., neighborhood street fairs).
- Honor frequent volunteer participants with a gift (mug, T-shirt, cap).
- Find ways to celebrate successes.

5

TOOLS AND TECHNIQUES: MANUALLY CONTROLLING WILDLAND WEEDS

There is no single right way to control weeds. Although there are many things to think about when deciding which method to choose, three factors are especially important: the nature of the infestation, the tools and techniques available to you, and the biology of the target. The first two issues are discussed in this chapter, while the third is covered in detail in the next chapter.

For various reasons, including liability and union issues, volunteer weed workers in the Bay Area tend to rely on manual techniques using hand tools. Even if you rely exclusively on such techniques in your own work, it's still quite useful to know about the wide range of other techniques that are employed. This chapter provides a broad overview of many control techniques followed by more specific details about manual techniques.

NATURE OF THE INFESTATION

Not all invasive plant infestations are the same. Some contain only a few plants, while others cover acres. Pulling the weeds out by hand might make sense in the former situation, but if the population is large, other techniques, like mowing, might be more appropriate. Terrain is another factor. Mowing works fine on level ground, but it isn't an option on steep or uneven terrain. Proximity to trails and buildings is yet another important thing to think about. Girdling a small invasive tree may make sense if you are working in a wilderness area far from trails or buildings, but it's not the best technique to use in less remote situations where the invasive tree might present a potential hazard to people or structures or where a dead tree might trigger adverse publicity.

In general, removing large trees is a job that should be left to expert arborists and foresters. When removal isn't an option, populations of invasive trees like blue gum eucalyptus can be contained using hand labor. Removing seedlings and saplings on the edges of the infestation will prevent it from spreading into adjacent native plant communities while you marshal support for the eventual removal of the larger trees.

It's important to keep these considerations in mind when choosing which tool to use. There are no hard and fast rules, so use your common sense, rely on your own experience with the land, and talk with seasoned weed workers if you're feeling particularly uncertain.

TOOLS OF THE TRADE

Relying on a single tool can get you in trouble. It's okay to develop a favorite tool, of course. The Bay Area weed workers who were consulted in writing this handbook each had their own favorite. Some singled out large tools like the Pulaski, with an ax and a hoe on the business end, while others picked much smaller tools such as the soil knife as their favorite. Between these two extremes there were many other preferences, which suggests that there is no single most useful tool for Bay Area weed workers.

They may have made different choices about their favorite tools, but they all shared an intimate familiarity with dozens of tools and techniques. They had avoided the common pitfall of tool users everywhere: if all you know is a hammer, then everything looks like a nail. Focusing on a single tool or technique just won't work when it comes to weeds. It's important to step back from the technology and think about the broader strategy.

INTEGRATED PEST MANAGEMENT

During the last few decades, farmers, ranchers, gardeners, landscapers, and land managers of all types have moved toward a comprehensive strategy for controlling weeds and other pests. This approach, called Integrated Pest Management (IPM), stresses the inclusion of all relevant factors in deciding which techniques are best for dealing with a weed problem. Thus, it is important to consider factors such as the technique's effectiveness in accomplishing your goal, potential disturbance to the environment, the period of time required for effective control, and the direct cost of a treatment technique. It is also important to note that weed workers and land owners may weigh these factors differently depending on their land management goals and policies, the environmental setting, and personal val-

Some General Comments about Weed Control Techniques

The following general considerations apply to all of the control techniques discussed in this chapter:

Minimize soil disturbance. Many invasive plants rapidly move into disturbed areas. In sensitive areas, particularly those that haven't experienced much disturbance, choose control techniques that minimize the level of disturbance. The number of volunteers you are expecting at a work party will affect your choice of site, target, and technique. You don't want lots of people working in a sensitive area with digging tools. The disturbance and trampling could outweigh the gains from removing the invasive plants.

Avoid disturbing wildlife. Limit cutting trees, tree limbs, or very large woody shrubs during bird nesting season as this could disturb or destroy nests. For this reason, the local units of the National Park Service generally do not work on selected weeds in forested, riparian, grassland, and scrub habitats during the nesting season, roughly March 15 to September 1. In some cases, however, where the invasive plant threats are high, park managers conduct nesting surveys prior to removal activities. If nests are found, the project is often placed on hold until after the nesting season is over.

Anticipate erosion problems. Rice straw, wood chips, or permeable landscape fabrics may help reduce erosion problems in areas where weed removal techniques like digging or scraping will leave bare ground. Wattles combined with organic materials such as jute can also be effective. This is particularly important when banks or slopes are exposed. For steep slopes and creek banks it is important to outline an erosion control strategy prior to removing weeds. This strategy should also be approved by the landowner.

Revegetate when appropriate. Cleared areas may need to be revegetated with native plants, but it might not make sense to do so until the infestation is well under control. If the site will require intensive weed control following initial treatment, it may make sense to wait a little bit longer before replanting. The new plantings will be vulnerable to damage during weed control operations. This is particularly true when working with sites infested with Cape ivy or French broom, both of which can require extensive follow-up treatment to deal with resprouting vine fragments or dense seed flushes. In the case of controlling annual grasses, planting shrubs (if appropriate to the environmental setting) can suppress weeds over time as the shrubs establish. Revegetation with locally appropriate plants is an art in itself and is not covered in this handbook.

ues and preferences. Consequently, they may ultimately choose different strategies for controlling the same weed problem.

How might this work with wildland weeds? Let's say you have a big, long-standing patch of French broom. You might use Weed Wrenches to remove the "old-growth" French broom, but that's just the first step. All that newly exposed ground will come up thick with broom seedlings during the next spring. Using a Weed Wrench on the seedlings would be impractical, and it would take a lot of volunteer labor to remove thousands of little seedlings by hand. So your next step might be to use a hoe or McLeod to cut back the seedlings or to ask park staff to spray the dense patch of broom seedlings with herbicide, or to flame it using a propane torch. Do this a couple of years in a row, and the density of broom seedlings might fall low enough for you to rely on hand labor again. An exclusive reliance on a single tool would be less effective in this case. An integrated approach, relying on multiple methods, best addresses the problem and helps native plants reclaim the area.

The four main methods used in IPM are cultural control, mechanical control, biological control, and chemical control. In general terms, cultural control is the least disruptive to the environment. The impact on the environment depends on the circumstances—all four control methods can cause significant impacts. You can minimize such impacts by learning which tools and techniques work best in particular situations. As someone who will be working mainly with volunteers, you may focus exclusively on mechanical control, but it's important to know what other methods are available as well.

Cultural Control

Cultural control refers to cultivation practices that limit weed populations. In traditional IPM, with its focus on cultivated environments like gardens and fields, cultural control includes a wide range of important techniques that help reduce pest problems: choosing pest-resistant plants, choosing the right plants for the right soil and water conditions, rotating crops, and companion planting. Other agricultural practices such as grazing, burning, flooding, mowing, disking, and mulching are examples of cultural control that can address wildland weeds. These cultural techniques can play an important role in an IPM approach to invasive plants in the Bay Area, but for the most part they're beyond the scope of this handbook.

Nevertheless, it's important to point out how effective cultural control techniques can be. Grazing, for example, is considered by some to be the only effective management tool for controlling annual ryegrass in large areas. Goats are often used in such situations. Utilizing goat grazing requires extensive planning. Will you manage them using fencing or herding? Are you willing to sacrifice any of the native plants in the area to be grazed? How long should the animals graze? The goats will eat almost everything. Other things to think about: the biology of the targeted weeds, the size and density of the infestation, and site conditions, particularly topography. Such considerations are important not only for goat grazing, but also for nearly every other control technique, including cultural ones.

Mechanical Control

For thousands of years, perhaps since the dawn of agriculture, humans have been using simple hand tools to remove weeds or simply pulling them by hand. Such methods can be very effective in controlling small populations of invasive plants, particularly where the weeds are intermixed with native plant communities, or adjacent to sensitive water bodies or rare plant populations.

There are other ways to physically remove weeds. In addition to the hand tools discussed below under "Key control techniques," large machines may be used to remove weeds. Special harvester boats gather up aquatic weeds and heavy-duty mowers have been designed to move through woody brush. Common construction tools like backhoes and bulldozers are sometimes used to pluck out large plants. Commercial logging equipment can be used to remove invasive trees. However, mechanical control, especially using heavy equipment, is not without risk. It can cause significant disturbance to soil and vegetation and can also introduce weed propagules and pathogens such as the one that causes Sudden Oak Death.

Biological Control

In a farm or garden, biological control can involve releasing beneficial organisms like ladybugs or lacewings that can reduce insect pest numbers. Biological control can also mean creating habitat for such beneficial organisms so that they can keep pest populations in check.

In the case of wildland weeds, classical biological control refers to the importation of host-specific insects or pathogens from the native range of introduced pest plants. (The lack of predation from such co-evolved species is one of the chief reasons that invasive plants can so effectively outcompete native plants.)

Once such organisms are located, extensive research is undertaken to ensure that they will feed only on the targeted weed and not on native plants or crop plants. There have been cases where classical biocontrol organisms have dramatically reduced invasive plant populations, but there are also a few cases where the introduced organism has expanded beyond controlling the intended weed and now affects native plant populations. Researchers at a USDA lab in the East Bay city of Albany are evaluating biocontrol agents for yellow starthistle, brooms, and Cape ivy.

Chemical Control

Herbicides are chemicals—usually synthetic—that kill plants or stunt their growth. Some herbicides are selective (clopyralid, for example, is used to kill yellow starthistle without harming grasses and most other forbs), while others are more general. Herbicides can be applied in many ways at many scales, from aerial spraying over large infestations to discrete brushing on individual plants. Extensive permitting regulates the use of herbicides, especially around surface water.

Liability concerns and state laws and regulations limit the unsupervised use of herbicides by volunteers, but a few Bay Area weed projects have set up programs in which supervised volunteers do use them. Whether operating in a voluntary capacity or for hire, on public or private lands, those using herbicides for wildland weed control must know all state and local regulations. You must understand how to read herbicide labels, the legal description of how the herbicide may be used. You must have landowner permission for the application. And on public lands, you must be trained by an applicator licensed by the state's Department of Pesticide Regulation. Some basic information on common herbicide treatments that have proven useful to some Bay Area weed workers is provided later in this chapter and also in the species accounts in the next chapter.

Environmental toxicologists study how herbicides and other chemicals behave in the environment, including their adsorption to soil particles, their ability to get into groundwater, their influence on other nearby plants through their roots, their rate of decay, and their level of toxicity to humans and wildlife. A good compendium of such information can be found in the Weed Control Methods Handbook on the Web site of the Nature Conservancy's Wildland Invasive Species Team.

KEY CONTROL TECHNIQUES

There are perhaps hundreds of tools that have been used by weed workers at one time or another, but they can be classified into fewer than a dozen major categories. In this section, we describe the fundamental techniques that Bay Area weed workers find most useful.

Pulling

Hands and strong backs are great "tools" for pulling weeds. The human body, despite thousands of years of experience pulling weeds by hand, is nevertheless susceptible to injury when doing so. The back is particularly vulnerable. Protect it using the technique you learned while hauling heavy boxes: lift with your legs, not your back. Wrists and forearms are also sensitive to injury. You can avoid repetitive stress injuries by varying your technique: switching from arm to arm, shifting from kneeling on one leg to the other leg, etc.

There is no single right or healthy way to pull weeds by hand, but you can encourage your volunteers to pay attention to their backs and other sources of discomfort. If it's uncomfortable, they should try another position or use a different tool.

Specialized tools like the Weed Wrench rely on leverage to help you pull woody stems right out of the ground. The Weed Wrench has a tall vertical handle connected to moveable jaws set on a base that rests on the ground. As the handle is pulled back, the jaws close around the woody stem and the base becomes a fixed point against which the plant can be levered out of the ground. These come in several sizes. The ones with longer handles and bigger jaws are needed to pull larger plants, but they are much heavier and awkward to carry very far.

Sometimes, in order to pull larger weeds out of the ground, you will rely on other types of tools to help you gain access to the roots or to loosen the surrounding soil. Shovels, mattocks, hand picks, and Pulaskis can be used to loosen a root ball and to sever tough roots. Pruners, loppers, saws, and other cutting tools can be used to cut roots or to trim branches that block access to the base of the plant.

To minimize soil disturbance when working with small plants, use one hand to hold the soil in place around the base of the plant while pulling with the other hand. Clumps of invasive grasses can be gathered into one hand while you use a soil knife in the other to cut an ice-cream cone shape around the base of the grass. Whenever a plant comes up with soil attached to the roots, shake it gently, preferably close to the ground and right above where you removed the plant. Don't forget that invasive plant seeds thrive in disturbed soil! So minimize disturbance when you can.

Digging

Digging is often done in combination with pulling. When removing yellow starthistle by hand, for example, it often won't come up until you use a digging tool to loosen the plant's roots from the soil. This may also be true when pulling large broom plants with a Weed Wrench. Digging tools from hand trowels to large shovels are useful for such tasks.

For the smaller plants, digging tools like trowels, soil knives, dandelion diggers, and even old screwdrivers and paring knives can be useful. Here your weed work most closely resembles gardening: weeding a newly planted area, attempting to eradicate an invasive plant population (that is, when you have to get every last plant and seedling), or the like. Using such techniques can be quite labor-intensive, so be sure that you will have enough labor to achieve your goal. If not, it may be better to choose a different goal, for instance, trying to control the yellow starthistle by mowing instead of trying to pull every last one. But that's not to be discouraging! Steady and persistent hand weeding over time can lead to dramatic success.

The most tenacious plants may not respond to pulling or cutting. Sometimes you just have to dig them out. Weed workers sometimes dig out big pampas grass clumps, for example, or the rhizomes of pepperweed or periwinkle. If the digging is extensive, it's wise to talk with the land manager's environmental compliance specialist. There may be archeological concerns that will limit the amount of digging you can do, particularly in areas of known archeological significance. Digging can cause irreparable harm to artifacts.

Long-handled tools like shovels or spades may tempt you to pry weeds out of the ground using leverage rather than digging them out. This may work in some conditions, but it can cause greater soil disturbance and damage the tool. Many shovels aren't sturdy enough to handle being used as a lever. There's a reason Tom Ness used steel in his Weed Wrench! (He developed the Weed Wrench while working on French broom in the Marin Headlands.) Consider using a long steel pry bar if you want to pry stubborn weeds out of the ground, limiting your use of shovels to lighter duty.

Picks and mattocks can be useful in rocky soils, or when the target plant has thick roots. Safety is particularly important with such tools. They should be carried head down, not over the shoulder. Keep well clear of others as you work. Swing the tool with knees bent and feet apart, so that you cannot slice into your shin. Swing from just above shoulder height and let the weight of the falling tool do most of the work.

When digging out plants, it's best to leave the soil on-site by shaking it gently from the roots and to avoid leaving large holes. Digging can cause considerable disturbance, so be certain that you have a plan to deal with the other weeds that may come in following disturbance. Visit the site again every few months to remove any weeds that have colonized the disturbed soil. If you stay on top of it, you can keep the early successional weeds under control relatively easily.

Scraping

Scraping tools are used to target seeds and small weeds or to create containment lines. Like digging, scraping is a form of soil disturbance, so make sure to deal with weeds that establish following scraping. Scraping tools can again be useful in that regard. Pattern hoes and oscillating hoes can be used to cut invasive plant seedlings and other small weeds just below the surface of the soil. McLeods and mattocks can do the same job. Tools with claws are especially useful for removing shallow roots from loose soil or duff.

Scraping is often undertaken to prepare a site for revegetation. Scraping a wild radish patch early in the season, not long after the radish seeds have germinated, will kill that batch of new radish plants and give you time to plant native plants instead. Some prefer to scrape the area twice or three times in a season to reduce the weed seedbank before planting natives in the scraped area. Take steps to minimize the potential for erosion during the critical time between scraping and planting. If there are native plant seedlings or plantings in the area, hoeing should be done by more experienced volunteers who can recognize the native plants.

Cutting

For some plants, cutting them off at or near ground level is the best way to kill them. This way you avoid soil disturbance and don't have to mess with tenacious roots. This works best with species that don't resprout, but there are techniques that work with those that do. A tree can be cut at the base with pruners (if it is a small sapling), with loppers (a bit bigger), with a pruning saw (bigger still), or with a chain saw (much bigger). You might use all of these tools in a single day. Your choice about which tool to use will depend on many variables, particularly safety issues.

There are lots of different cutting tools and each one has an important role to play in your toolkit. Choosing the right one often depends on biological considerations, safety issues, and efficacy. Over the years, weed workers have developed several key techniques that involve cutting woody plant tissue in some manner. Here are some of the most useful ones.

Cutting. For some plants, cutting them off at ground level is sufficient to kill them. Monterey pine trees, for example, do not resprout as long as they are cut low enough. Cutting can also be a first step in preparing a plant for complete removal later. For instance, weed workers may use a chainsaw to trim back pampas grass to a point where they can dig it out of the ground. Infestations of weedy vines, which twine through woody thickets but are rooted in the soil, often require extensive use of cutting tools to clear away the thickets before the vines can be completely removed.

Grinding or macerating a cut stump. Stump grinding or macerating can also be used to prevent stump resprouts. Though grinding machines are expensive to rent and can be awkward to use in wildlands, some Bay Area weed workers have used them. Stumps are typically ground to a depth of about two feet below the ground. If only a few stumps need grinding, some weed workers remove enough soil around the base of the trunk so that they can cut it just below ground level without getting the chainsaw bar in the dirt. Some practitioners macerate cut stumps to inhibit resprouts. They do this by using a chainsaw to make cuts in a grid pattern (one- to two-inch squares) approximately two to four inches deep in the cut surface of the stump.

Tarping a cut stump with landscape fabric or black plastic. In this treatment, the stump is cut low and level, then covered tightly with landscape fabric to prevent it from getting any sunlight. The fabric is spread at least two to three feet beyond the edges of the root crown to prevent resprouts from photosynthesizing. Care is necessary to make sure that individual pieces of fabric have enough overlap so that resprouts can't squeeze up between the seams. Because seams tend to be a source of failure, avoid using tarps with seams if you can. The fabric is staked down every few feet—or even every six inches—with U-shaped wire staples to make sure the tarp is securely fastened. Some weed workers even dig a trench around the target and completely bury the edges of the tarp. Covering stumps is feasible only for small areas and needs to be checked two to three times a year to make sure that sprouts haven't burst through the fabric or emerged around the edge. Cut stumps may require up to a year or more of covering to prevent resprouting. The fabric can also be covered with mulch to improve the aesthetics.

Treating a cut stump with herbicide. Many plants, including blue gum eucalyptus and acacia, resprout vigorously after being cut. Repeated cutting may eventually sap the plant of its vigor, but it requires intensive follow-up work, and is seldom efficient unless you have extensive volunteer resources available to prevent resprouts from establishing. That's why many weed workers treat the cut stump with an herbicide such as triclopyr or glyphosate. Practitioners use a high concentration of herbicide—no more than 50 percent, according to some—and apply it immediately upon cutting since the plant tissue heals rapidly, inhibiting uptake of the herbicide. The herbicide needs to be applied only to the exposed cambium, the living tissue in the trunk. It's wasted anywhere else. Unless aesthetics or safety are problems, cut the stump flat at a height of eight to ten inches. Then if it resprouts even after treatment, the stump can be cut again and retreated with herbicide. If aesthetics are a concern, stumps can be cut low and level and, once the herbicide has had a chance to work, covered with a thin layer of mud or brush to reduce the visual impact of newly cut trees.

Girdling, frilling, and drilling. These techniques all take advantage of the vulnerability of the cambium in order to kill a standing tree without felling it. The plant will die if this narrow band of living tissue encircling the entire tree just under the bark is damaged in such a way that it cannot transport water and nutrients between the roots and the rest of the tree. If a small section remains uninjured, however, the plant will keep growing and perhaps even heal the wound over. In most cases, it is preferable to cut down trees, but girdling and the like can be useful in relatively inaccessible areas where the dead tree will become a snag that will be useful to wildlife. These techniques should not be used if the standing dead tree will become a safety hazard or an aesthetic problem, or if it is in an urban setting that could generate controversy. Girdling involves cutting through the bark and the cambium all the way around the trunk, and is often done using a chainsaw. Frilling accomplishes the same goal without using power tools. Cut long slices downward through the bark to the cambium and then peel them downward. Frilling tends to lose its effectiveness on trees larger than two feet in diameter because their bark becomes too thick for peeling. Another technique, which can be even more efficient and effective, involves drilling small holes in the bark and injecting herbicide. You need to know the proper herbicide type, concentration, and amount. Some practitioners have found that when drilling and injecting herbicide, a 50 percent solution of glyphosate works best. As with all herbicide treatments, this treatment requires supervision, training, and a prescription from a state-certified applicator.

Weed whipping. The next two techniques rely on power tools to increase the number of plants you can cut. As a result, they can be more effective and efficient in certain situations, but also more dangerous. Weed whipping offers the cutting power of a lawn mower but can reach tight spots a mower won't. It relies on a more powerful version of a tool familiar to many homeowners and known variously as a weed whip, weed whacker, or string cutter. A brushcutter, a larger and more powerful version of the weed whip, can be fitted with nylon string, rigid plastic cutting blades, or a wide variety of steel blades ranging in suitability from brush to small trees. A gas-powered motor spins a cylinder at the end of a long metal tube. When a canister containing nylon string is attached to the cylinder, the brushcutter can be used for cutting grasses, seedlings, or herbaceous plants like yellow starthistle. The nylon string doesn't work very well when the vegetation is wet. If the area is perpetually damp, or the vegetation is thicker than can be cut using nylon string—even the newer versions that are reinforced with steel or Kevlar—consider using other techniques. The rigid plastic blades can be very effective with tougher herbaceous weeds or small brush seedlings.

Brushcutting. When fitted with a metal blade, a brushcutter can be very effective in opening up areas covered by tall stands of woody invasive species up to two inches in stem diameter. Brushcutting tends to be used with larger infestations and in places where plants have become overgrown. This can be used as a way to prepare a site for pulling plant roots with a Weed Wrench—in which case, don't cut the stems so low that the Weed Wrench won't be able to grab them—or treating the cut stumps with herbicide. It is sometimes a challenge to move plants that you have just cut so that they are not in your way for cutting other plants. A second person can help with this, but it presents obvious safety concerns. The engine is often loud and the metal blade can throw stones and other debris, so operating a brushcutter (or working near one) requires extensive protective gear and safety training. For the operator, chaps, helmet, face screen, and ear protection are *de rigueur*. These hazards, particularly the noise, require you to be very sensitive to the safety and comfort of park visitors as well. Using a brushcutter along a busy trail is to be avoided. The metal blade can also throw sparks when it hits rocks, so avoid its use in dry conditions when the fire hazard is high; use plastic blades or string in such conditions.

Mowing. Gas-powered mowers, especially the heavy-duty types used by maintenance divisions in park and open space agencies, can provide some control of certain invasive plants in grassland situations. Yellow starthistle, for example, when mown just as it begins to flower, can be knocked back significantly if done for two to three years in a row. Mowing to prevent seed set can keep some invasives from spreading while you reduce the size of the infestation with other methods. Timing is key. Mowing after invasive annual grasses have gone to seed obviously won't help. Mowing can also present problems if the target plant's seeds can continue to ripen even after being cut off (many thistles) or will reroot or resprout from cut stems (Cape ivy). A tractor-mounted mower can be effective on large parcels. Many different sizes can be rented and delivered to the site. A trained operator is required, as is a site that has been cleared of barbed wire, rocks, and other things which could get caught in the blades. Mowing is often best done in combination with other techniques, like hand pulling subsequent seedlings if they're not too numerous.

Applying Herbicides

There are several simple techniques for weed workers applying herbicide in situations where the landowner or manager has established the appropriate protocols and procedures to comply with pesticide regulations. These techniques require training and supervision by a licensed applicator and should not be undertaken without landowner approval and training certification. Before using such techniques, consider posting signs notifying the public that herbicides are being applied in a particular area. (Depending on the jurisdiction, this may be required by law or regulation.)

Cut-stump treatment. The role of this technique is described in the cutting section above. Herbicide at high concentration is applied to the cut face of the stump either by painting it on with a small brush or by spraying it on using a small bottle like those used to mist houseplants. Because you have direct access to the cambium, the amount of herbicide required is low, especially given the size of the plant. There is little danger of the herbicide contacting other plants directly when using this treatment.

Foliar spray. This technique delivers herbicide to a plant through its foliage, so it uses herbicide less efficiently than in the cut-stump treatment. Because the herbicide is being sprayed, there is the possibility of contacting non-target plants, which can result in undesired damage if you're using a non-selective herbicide like glyphosate. Many applicators use a backpack sprayer, which typically carries several gallons of diluted herbicide. The sprayer tank is kept pressurized by pumping a lever, and herbicide is sprayed from a wand. Wind conditions are always measured, because you are prohibited from spraying in any breeze over a low threshold to avoid drift. To ensure sufficient uptake into target plants it is necessary to cover their leafy surfaces thoroughly. This is easy on small plants, and harder on larger plants. Foliar spray tends to be ineffective on plants that have leaves with thick waxy cuticles.

Wicking. A wicking wand has a sponge on the end that is used to wipe herbicide onto a plant. This can be used for a foliar treatment, in which it has the advantage of getting less herbicide on non-target plants, but the disadvantage of taking more time to coat all surfaces. Wicking wands can also be used for basal bark treatments on woody plants, where herbicide is painted around the bark at the base of the main trunk. This treatment uses special additives that allow the herbicide to penetrate the bark and move into the root system.

A Few Other Techniques

A few additional control techniques are hard to classify. These include:

Solarizing. This technique takes advantage of the vulnerability of plant tissue to extreme heat. A clear plastic tarp allows sunlight to penetrate but traps the heat. In sunny climates the heat can be high enough to kill the plants under the tarp. In practice, the technique is identical to that used in covering a cut stump with landscape fabric, but in this case a clear plastic covering is used. (See Tarping treatment for details.) Solarizing may require up to a year or more of covering to kill the plants underneath the tarp. This technique is ineffective in foggy coastal areas, but weed workers in the East Bay and other areas with hot summers may find it useful for controlling small infestations of certain herbaceous weeds. Some practitioners prefer black plastic, finding it more effective than clear plastic even in inland areas as well as along the coast.

Flaming. Like solarizing, this treatment also relies on the vulnerability of plant tissue to heat. In this case, a propane torch is used to speed up the process. Some weed workers have found that it can be quite effective in controlling the thousands of French broom seedlings that emerge after a large stand has been removed. Others have recently cited success with poison hemlock. However, its true potential is yet unknown, since this agricultural weed control technique is only now being adapted to wildland weed species and conditions. Stay tuned! As experience accumulates, it's likely to become an important and effective tool for controlling herbaceous invasive plants or small shrub seedlings. Flaming has several advantages, including avoiding ground disturbance, extending the season to include wet and cold weather (using it keeps you warm), and providing greater selectivity than herbicides (it works only on very young plants). Technique, timing, and safety issues are key concerns. The seedlings are not actually burned, but rather heated to the point at which the water in the plant cells boils and ruptures the cells. (Some weed workers describe this technique as "blanching" rather than "flaming," and if you know your cooking terms you know why.) This stage is not always obvious to the torch operator, so it can be a difficult technique to learn properly. It is best to learn from someone practiced in the art. This treatment should be used only when it is raining or immediately thereafter. For obvious reasons, a propane torch should not be used in wildlands when there is any risk of fire whatsoever. Like many of the techniques described in this book, it is important to gain approval from the land owner or manager prior to implementation, and in this case consultation with your local fire department is a wise precaution.

Mulching. Mulching can be effective for smothering small infestations of herbaceous weeds like kikuyu grass or Harding grass that are hard to control using other techniques. Cover it first with a weed barrier—landscape fabric, nylon, plastic, even cardboard or old carpet—and then place three to six inches of rice straw or wood chips on top of that. Some people prefer fabric over plastic because of its superior ability to let water infiltrate into the soil and prevent erosion problems. Be sure to get *weed-free* mulch. Once the plants underneath are dead, removing the weed barrier will allow you to revegetate the area with native plants. If the barrier material is biodegradable, you can also plant directly into the fabric, cutting small holes to insert plants. Using an organic mulch can alter soil conditions, so this treatment should be used only in areas that have been highly altered already.

Managing Debris Appropriately

Whether pulled, dug, or cut, invasive plants are still invasive plants. Dealing with such debris is an important and often underestimated dimension of weed work. This is especially true for plants like Cape ivy, which has an almost miraculous ability to regenerate from the smallest bits and shreds. (It's so tough that it's been known to resprout even after being bagged in black plastic and left in the sun for months in the heat of a Central Valley summer!) When making plans about how to manage invasive plant debris, take into account considerations like the plant's biology, vehicular access to the site, available resources, and site aesthetics. Before embarking on a weed project, always ask yourself: what am I going to do about the debris? Here are some common techniques for dealing with invasive plant material:

Leaving on-site. This is the simplest method. Pull up the plant and leave it right there. It works only if your target plant cannot reroot or resprout, occurs in low densities, and decomposes quickly, as is the case with many herbaceous plants. If you're working on small, dispersed pioneer populations, this strategy often makes good sense.

Piling on-site. This treatment is commonly used for dense stands. By piling the debris in a few stacks rather than scattering it across the entire site, you will free up space for native plants to begin regenerating. (Building high stacks can also provide you and your volunteers with a visible sense of accomplishment—take pictures of your group in front of the debris pile at the end of the day!) Some weed workers pile debris in such a way that they can burn the stacks later in the year, during late fall or early winter, for example. (As with all land management involving prescribed fire, it's important to consult with the local fire department and obtain all appropriate permits.) Others have found that wood and brush piles can provide valuable habitat for wildlife. Aesthetic concerns may compel you to stash debris away out of sight, but this can lead to new infestations if you're not careful. Debris piles often need to be monitored for resprouts and hiding them can make them hard to relocate. If your target is a resprouting vine like Cape ivy, it is often best to cut a containment line around the debris or pile it in the middle of a large tarp. Bucking and tarping on top can also help. In such situations you can separate clean, completely uninfested woody debris (which won't resprout) from herbaceous debris containing Cape ivy. This will reduce the number of Cape ivy-infested piles, and it will be easier for you to deal with resprouts if they're not entangled with branches. Whatever approach you use, monitor regularly for resprouts for several years.

Avoid piling dead plant material in areas where target weeds are likely to grow. For example, if the target quickly colonizes moist soils, consider placing debris in upland areas.

Hauling off-site. This treatment is feasible only when the site is easy to access by vehicle. It is a useful option when working with tree debris or weeds like Cape ivy that have the ability to resprout from the tiniest stem. Hauling and dumping fees can be quite expensive, so be sure to estimate accurately the volume of debris before choosing this technique. For plants that spread by seed, you can reduce the amount of debris by cutting and bagging the seed heads from the invasive plant before removal. This is sometimes done with pampas grass, but only in outlier populations. When invasive plants are still in the early stages of invasion, it is also often worthwhile to bag plants that may contain viable seeds. Better to haul a few bags away than to take a chance that the viable seeds will reinfest the site. And of course, you want to make sure that the destination site for your hauled debris is not likely to be the source of further infestations (landfills are generally fine, as are composting operations as long as they are hot enough to kill weed seeds or fragments).

Chipping on-site. This treatment can be useful if you are dealing with tree debris and the site is easy to access by vehicle. Branches up to three to four inches in diameter can be chipped into the back of a truck or, if ecologically appropriate, left on-site. Larger pieces of wood can be hauled away for lumber or firewood or left on-site. Like chainsaws and brushcutters, using a chipper requires training and careful safety practices. Make sure you have trained operators prior to using chippers.

TOOL SAFETY, CARE, AND SELECTION

Using a tool safely depends on knowing how to use it properly. Some tools, like a trowel or a dandelion digger, are easy to figure out on your own. Even if you don't quite get it right the first time, you can't inflict much damage on yourself (though one weed worker reported getting a bad blister on his palm the first time he used a dandelion digger without gloves!). Your margin of error for safety is much smaller when working with power tools or tools with sharp blades. That's why it is best to insist on proper training in tool use and safety.

Those working with volunteer weed workers often rely on manual tools because it is possible to train volunteers to use them safely and properly in a relatively short time. Teaching someone how to use a Weed Wrench takes no more than five minutes. Using a Weed Wrench is not without risk, but the infrequent injuries that can occur are relatively minor—bruises, bumps, and backaches mostly. As this example illustrates, many manual tools have two important advantages over other tools: they are relatively simple to use and the risks of their use are relatively minor. (That said, even simple tools like hand picks can be quite hazardous in the hands of a rambunctious crowd of teenagers. Remember one of the ABC lessons in chapter 3: know your Audience!)

It is true that volunteers can be taught how to safely use manual tools with sharp blades. Using a machete is straightforward—it's a simple and very effective tool in brush—but the consequences of an accident are much more severe than they are when using other tools. That's why very few weed workers who work with volunteers use machetes. They choose tools more appropriate for the skill level of their volunteers, even if this means avoiding tools that may be more effective in objective terms (that is, when used by an experienced worker).

Choosing the right tool for the job is not just a decision about technology, but also about sociology. Chapter 4 contains additional considerations about tool safety and use when working with volunteers.

All weed workers using power tools should receive careful training in tool safety, use, and care. For public agencies who are willing to allow volunteers to use power tools—and such agencies are in the minority—this often takes the form of an all-day or half-day workshop.

A well-made tool can last a long time if it is cared for. And a well cared-for tool is also a safer tool. Tool care is often a neglected art, though, which has led exasperated managers to take several approaches for dealing with the problem. One approach is to dedicate the last fifteen minutes of a work party to tool care and cleaning. (Removing seeds and soil from tools and boots is important when dealing with invasive plants because otherwise there's a chance that you and your tools will be transporting invasive plant seeds.) Or you can set aside one work day every few months to paint, repair, and sharpen your tools. Some programs find dedicated volunteers or staff members who enjoy tool care to take responsibility for tool maintenance.

If you have responsibility for choosing tools, choose high-quality ones. Cheap tools usually fall apart rapidly under the stress of vigorous weed work. (On the other hand, you may be better off with relatively lightweight tools, especially if you work with children.) You may choose to purchase or borrow a variety of tools for your work parties—all kinds of volunteers are then likely to find something they're comfortable with—or focus on just a few types of tools, simplifying your planning and training.

WEED WORKERS' TOOLS EXPLAINED

Tool	Target	Considerations
PULLING		
Weed Wrench	tap-rooted shrubs, small trees	works best in winter and spring when soil is moist; can cause soil disturbance; works best with vertical rather than horizontal taproots
pliers	seedlings, narrow-stemmed plants	easy to carry; easy to lose
McLeod, rake	vines	
DIGGING		
round-point shovel		standard multi-purpose shovel; long handles increase leverage; some may prefer short handles
spade		flat-edged, short-handled shovel; only marginally useful
transplanting spade, or sharpshooter		long narrow-bladed shovel, effective on deep root systems; forged steel work ones are much better than cheap stamped steel; if careful, can be used to lever plant out of the ground
trowel	small plants	useful for planting or transplanting small plants; good tool for children
soil knife	small, tap-rooted plants	point penetrates pliable ground easily; serrated blade lets you cut what you can't dig; creates less soil disturbance than trowel
dandelion digger	small, tap-rooted plants	
mattock	deep-rooted plants	requires proper training
Pulaski		a favorite all-purpose tool for many weed workers; useful for grubbing out or cutting down almost any plant; can be used for frilling and girdling; light-weight versions available
hand pick		one-hand tool for smaller scale weed removal
digging bar, rock bar		useful for loosening hard soil and rocks deep below the surface; can bend if used for prying
pry bar		useful for prying up roots

Tool	Target	Considerations
SCRAPING		
McLeod, cultivator fork, other tools with tines	mats of invasive perennials in monoculture, including grasses	McLeods are a good multi-use tool for scraping surface debris fromthe ground, hacking out small roots, and raking small brush; requires follow-up for resprouts and seedlings; requires some training
pattern hoe	seedlings and small plants	requires basic training
oscillating hoe	seedlings and small plants	can push or pull, providing versatility; requires basic training
CUTTING WOODY PLANTS		
pruners	woody stems <½ inch in diameter	anvil pruners (one sharp blade and one flattened one) require less force to cut the same stem than bypass pruners (sharpened blade slides past curved blade); inexperienced users can ruin bypass pruners by twisting them in the cut; bypass pruners can make cleaner cut
loppers	woody stems ½–2 inches; tree and shrub limbs; stalks of large herbaceous vegetation	loppers come in two basic types too: anvil and bypass (see above); longer handles allow for greater leverage when cutting through woody stems; can be ruined if used inappropriately; requires some basic training
pruning saw	woody stems <10 inches in diameter	some come in a folding version; a favorite tool for many weed workers; can get pinched in large branches if not careful
hatchet, ax	large shrubs, small trees	useful when you don't have access to a pruning saw or chain saw; let the falling weight of the tool do the work; position your feet so that you won't accidentally hit your legs if you miss; dangerous tool in inexperienced hands; also used for frilling and girdling
Pulaski	large herbaceous plants, large shrubs, small trees	can be used like an ax to cut, frill, or girdle, can be used to hoe out root pieces; requires training for both safety and technique
bow saw	woody stems <18 inches in diameter	available in many sizes; useful for sawing through limbs and small trees; used primarily for large blocks of wood like logs; commonly used in trail work
limbing saw	woody stems <18 inches in diameter	mostly used by arborists for small limbs

Tool	Target	Considerations
chainsaw	woody stems	versatile but noisy and requires extensive safety training; helpful and safer to work with a swamper to remove debris and provide assistance when required
brushcutter	woody stems <4 inches in diameter using steel blade	versatile but noisy and requires safety training; helpful and safer to work with a swamper to remove debris and provide assistance when required; should not be used on steep or very rocky slopes
CUTTING HERBACEOUS PLANTS		
weed whip	small areas of grasses, herbaceous annuals, or perennials	versatile but noisy and requires safety training; useful for light-duty selective mowing in grasslands
brushcutter	grass or seedlings using nylon string or rigid plastic blades; vines or groundcover using toothed steel blades	versatile but noisy and requires safety training; helpful and safer to work with a swamper to remove debris and provide assistance when required; should not be used on steep or very rocky slopes
mowers	grass or herbs	useful in large, flat areas
machete	almost anything	too dangerous for common use; requires proper training in both sharpening and user technique; must be regularly and expertly sharpened; a dull machete is more likely to cause injury
scythe	grass	not commonly used anymore, but can be a very effective tool, if sharp and used properly, in uniform grasslands; difficult to learn proper techniques for sharpening and use
hand scythe	grass; inflorescence removal before seed dispersal	relatively safe, good for cutting grass in sensitive areas; not appropriate for large-scale control
Swedish brush ax	brush and small woody stems < 4 inches diameter	relatively safe, but any sharp-edged tool entails risk; requires proper training
Japanese sickle		relatively safe, but any sharp-edged tool entails risk; requires proper training
pocket knife	shrubs and small trees	can be used for girdling when no other tool is available; versatile multi-use tool that can come in handy
OTHER		
flaming equipment (propane torch and portable tank)	small seedlings, soon after germination	safety an issue; best conducted in wet season; may require multiple treatments in one season as germination is staggered

Tool	Target	Considerations
landscape fabric, black plastic (6 or 10 mil)	clonal mats of vines and grasses	use plastic rather than fabric when moisture barrier is needed; use fabric to allow moisture percolation into the soil; 6 mil breaks down in about a year in sun; 10 mil lasts at least twice as long
wire staples		staples can be used for securing fabric edges when the ground is pliable; otherwise dig a trench and bury the edges; requires long-term commitment of 1–2 years; must be well-fastened to endure weathering 1–2 years; not for use in high-wind environments; aesthetics may be an issue
wheelbarrow, plastic bag, woven polypropylene bag, tarp		all can be used for hauling vegetative material; wheelbarrows can be bulky and unwieldy to handle on pickup trucks; plastic bags rip easily; some prefer to use strong tarps, which can be lifted at the corners and dragged or carried
rake		useful in areas with high visitor use; flexible rakes useful for cleanup; hard rakes useful for piling debris
push broom		useful in areas with high visitor use
hay fork, scooping fork, ensilage fork		great for loading or unloading vegetative material
static kernmantle rope		knowing a few basic knots turns a length of rope into an assist for short climbs, a loop for dragging brush, and a multitude of other uses

WEED WORKERS' TOOLS ILLUSTRATED

(note: drawings are not to scale)

weed wrench

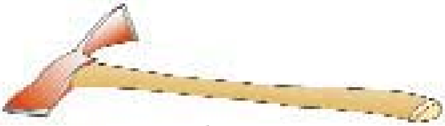
McLeod

oscillating hoe

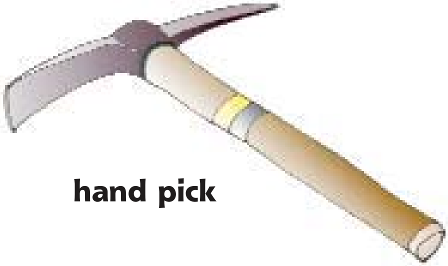
round-point shovel

fire rake

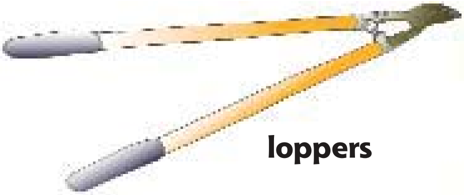
rake



Pulaski



hand pick



loppers

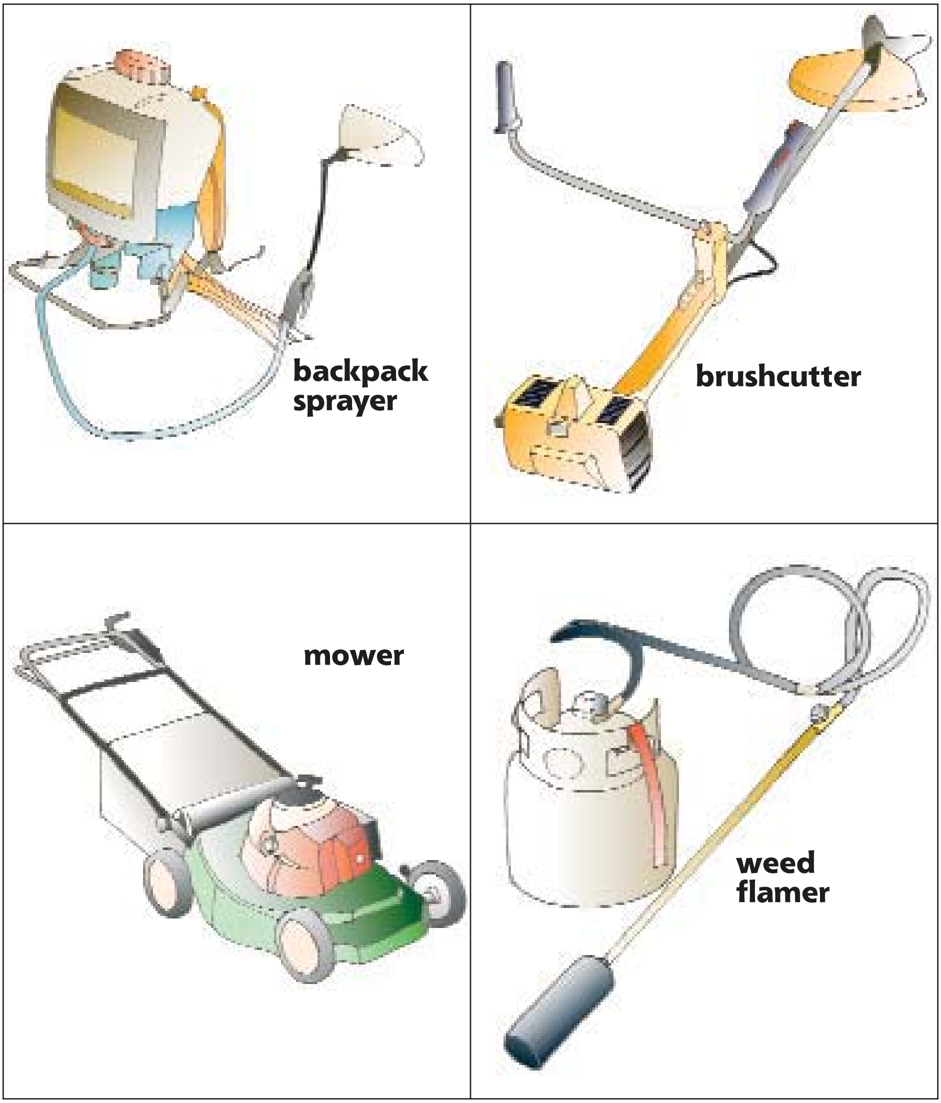
small loppers

hand saw

hedge trimmer

machete

soil knife


backpack sprayer
brushcutter
mower
weed flamer

6

THE PLANTS: HOW TO REMOVE BAY AREA WEEDS

The weeds presented in this chapter are significantly affecting Bay Area ecosystems. Local landowners, conservation organizations, and volunteer weed workers have identified these plants as important to control in Bay Area watersheds. While other weeds also affect local natural areas, we have chosen to provide a comprehensive resource for these species in this book.

Each species account includes a description of the plant and its modes of reproduction, followed by its ecological impact, treatment options for removal, and notes on disposal and follow-up. A wide range of treatment options is presented so that you can select the approaches best suited to your site and resources. (Refer to chaper 5 for detailed descriptions of each of the control treatment options.) Each account also lists key factors of the plant's biology that are important to consider when planning a control program.

Following is a discussion of how biological characteristics—modes of reproduction and life cycles—affect choices and strategies for effective weed control efforts.

REPRODUCTION: HOW IT AFFECTS WEED REMOVAL

By definition, weeds are plants that reproduce very successfully in the habitats they invade. We should note that weediness is not a fixed characteristic of a plant, but a reflection of its impact in a particular environment. Some invasive plants are prolific seeders and early colonizers even in their native range, while others are surprisingly rare in their native range. For these plants, the absence of predators and diseases, recent or historical habitat alteration, or other ecological circumstances enable them to invade where they are introduced. In such cases weed removal may be only one component of habitat restoration. Whatever the factors that enable a plant to become a weed, understanding its modes of reproduction and its life cycle will help you choose techniques, evaluate progress, and follow up appropriately until you succeed in controlling it.

Some plants reproduce exclusively from seed. Some are equally prolific by sexual and vegetative reproduction. Others reproduce almost exclusively vegetatively, and either rarely produce viable seed, or their seeds rarely encounter the right conditions to germinate. In sexual reproduction, male and female gametes combine and produce genetically different offspring through flowering, pollination, and seed production. In asexual (or vegetative) reproduction, new individuals—clones—can grow from a part of a plant, such as a node or a root.

Sexual Reproduction

Evolution has produced myriad ways by which seeds—those precious packets of genetic information—are dispersed. Some seeds drop close to the parent plant, while others are carried a considerable distance on the wind; some are eaten by birds and dropped even greater distances; others still are transported by flowing water. Perhaps the greatest aid to seed dispersal, however, is the movement of humans. (This is how many weeds were introduced in the first place!) Some seeds are transported by clothing, boots, and vehicles from mountain bikes to earth-moving equipment.

Effective control techniques are linked to these means of seed dispersal. For example, if a seed is transported by water, consider trying to control upstream infestations first to prevent continual re-invasion. If seeds come packaged in fruits that are eaten and dispersed by birds, consider trying to remove the plant before fruits ripen. When you don't have the resources to remove entire plants before seeds are produced, you may chose to remove just the seeds for that season if practical. Another important consideration is seed viability. Knowing how long seeds can persist as a viable seedbank will help you decide how many years you will need to follow up on removing seedlings after the initial removal of an infestation.

Vegetative Reproduction

Plants can produce new individuals by many means other than seed. Vines can cover a lot of ground simply by vegetative growth—not technically reproduction—before they ever flower. Bulbs, rhizomes, stolons, and runners are not roots, but shoot (stem) tissue that can give rise to new plants. Tillers and suckers are shoots that emerge directly from a part of the root, growing adjacent to or at some distance from the main stem of the parent plant. Some plants can produce shoots and roots directly from stem nodes or branch tips that touch the ground. Others can regrow from a cut stump or from parts of roots left in the ground. For our purposes, such regeneration can be considered vegetative reproduction, because without follow-up, it can produce a whole plant.

The amazing array of possibilities for vegetative reproduction gives rise to a long list of considerations for treatment and follow-up. Can the target weed resprout from a cut stump? If so, you may choose to implement one or more of the following options until the species is controlled: cutting resprouts until energy resources are depleted, covering the stump with landscape fabric, treating with herbicide, or removing the stump and roots entirely. Can a patch continue expanding outward via rhizomes or tillers? If so, you may try to control the perimeter until you can remove the whole patch. Can small fragments of stems that contain a node produce an entire new plant? If so, you may find yourself regarding weed debris as hazardous waste when you contemplate disposal.

Life Cycles

In addition to differences in modes of reproduction, plants have different life cycles: annuals complete their life cycle in one year, biennials in two years, and perennials live for three or more years.

- **Annuals** reproduce exclusively by seed. An example is yellow starthistle, a winter annual that produces copious amounts of seed. (Winter annuals germinate in the fall, overwinter as seedlings, and die in the spring or summer soon after setting seed.) Because individual plants do not persist beyond one year, the main control concern with annuals is preventing seed production to minimize the number of future plants.
- **Biennials** develop strong roots during their first year, storing the energy they need to survive the winter. Bull thistle, like many biennials, overwinters as a basal rosette of leaves. This is a good time to pull plants up by hand as the taproot is relatively weak. In the second year, biennials bolt and flower. By this stage, not only is the taproot stronger and the plant more difficult to pull up, but soon the plant will produce seed.
- **Perennials** often reproduce both sexually and vegetatively, thus requiring a range of treatments to control or remove them. Perennials can be divided into woody perennials (trees, shrubs, and some vines) and herbaceous perennials (forbs, grasses, and some vines). Woody perennials have persistent, hardy stems. Herbaceous perennials often have stems that die back during the winter but roots that persist, with new stems growing from the root crown each spring. Treatments for perennial weeds are often designed to make an impact on their most resilient part—the roots. If the plant can regrow from stumps or roots, the control strategy may also include repeat treatments to exhaust the plant's energy stores.

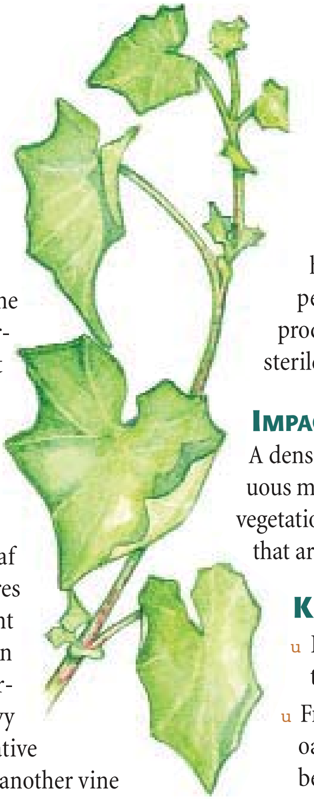
The species accounts that follow are grouped by growth habit (vines, shrubs, trees). Herbaceous plants are further divided by life cycle (perennial or biennial forbs, annual forbs, perennial grasses, annual grasses.) Within each section, the plants are ordered alphabetically by common name. The illustrations that accompany each description are not to scale.

VINES

CAPE IVY

Delairea odorata

(formerly known as German ivy, *Senecio mikanioides*)
Sunflower Family (Asteraceae)



Description

Cape ivy is a climbing perennial vine usually found in coastal and riparian areas and on disturbed moist sites. However, it is a highly adaptable species that will proliferate in a wide range of ecosystems.

Both the leaves and stems store water, making the plant drought-tolerant. A single leaf grows from each node and measures 1–3 inches long. The succulent leaves are smooth and bright green with pointed lobes. The underground stolons are purple. Cape ivy is commonly confused with native wild cucumber (*Marah fabaceus*), another vine with similar leaves. Unlike Cape ivy, however, wild cucumber has thicker stems, spiraling tendrils, hairs on the leaves, white flowers that bloom in spring, and spiny fruits.

Reproduction

Cape ivy grows vigorously, particularly from February to June. It reproduces vegetatively by rooting from stem, stolon, or petiole (i.e., any part of the plant except the leaf blade) that touches the ground. Infestations can be spread by a variety of means, such as machinery or water, which carries fragments downstream. Cape ivy has no taproot, only shallow adventitious roots that grow to 4 inches deep in the soil. In areas with little summer moisture or with frost Cape ivy will experience some dieback, only to resume growth with the fall rains. Small, yellow flowers with green tips bloom between December and February. Cape ivy seeds have a hairy apex and are wind-dispersed. However, most seeds produced in California appear to be sterile.

Impact

A dense, sometimes heavy, and continuous mat of Cape ivy can blanket native vegetation. Cape ivy contains alkaloids that are potentially toxic to fish.

Key Factors

- Reroots from fragments left in the soil.
- Frequently grows among poison oak, stinging nettle, and blackberry.
- Thrives near moisture.

Treatment Options

Removing Cape ivy requires precision, as every little part of the stem needs to be removed. Given the time and resources that controlling Cape ivy demands, practitioners have found it is sometimes advantageous to focus on removing the Cape ivy around the perimeter of a patch, rather than all-out removal. The control method chosen depends on patch size and isolation, the resources available for control, and the threats posed by Cape ivy to valued resources.

- **Cut** a containment line by clearing a strip of bare earth around the entire perimeter of a Cape ivy infestation, as if you were cutting a fire break. The strip should be roughly 1 yard wide, depending on site factors such as public visibility and soil moisture. This helps to prevent spread as Cape ivy grows more slowly on bare soil. Begin from the edge of an area and work your way inward. You can sometimes peel back the edges of an infestation, where the vine is more lightly rooted, and roll the vegetation like a carpet. Tease or dig out stolons with a small Pulaski, fork, McLeod, or hand mattock if needed, following the runners to their source. Many hand tools work well. You can rake the soil surface several inches deep to comb out any remaining stems and roots fragments. Check the line periodically (4–6 times a year at moist sites; at least 2 times a year elsewhere) for Cape ivy spreading.

Some practitioners have used a more intensive approach—especially in riparian and dense scrub habitat—by clearing both native and invasive vegetation to establish initial containment/removal lines and access Cape ivy resprouts. This requires chainsawing limbs off trees and shrubs to about breast height. Make sure limbs are removed from the area as Cape ivy may also reestablish in debris piles. Rakes or McLeods can help to pull loosely attached vines climbing up a tree, or you can cut the vine with loppers and leave the ivy to die in the tree.

Sites cleared of Cape ivy may be vulnerable to erosion or colonization by other invasive species. When working next to a creek or river, work your way from upstream to downstream to prevent recolonization by stem fragments transported by water.

- **Cut and treat.** Cut climbing vines with loppers and paint stems with herbicide. Because Cape ivy nodes break easily, it may help to place tarps on the ground around trees in order to catch any stem fragments that break as you work.
- **Graze.** Some land managers have attempted using goats as a pretreatment. Audubon Canyon Ranch grazed 60 small female goats for 1 week on a half-acre site; the goats grazed the foliage but not the stolons.

Disposal

Some practitioners pile the plant material on a tarp to dry out in the sun, making sure no roots touch the ground. The Cape ivy should break down quickly, especially if the piles are turned frequently. However, there is a chance that Cape ivy will sprout even after long drying. Establish and maintain a containment line around larger debris piles. As a final measure you can spray the piled debris with a weak glyphosate solution. Alternatively, bag all parts of Cape ivy and remove them from the site. You may also need to remove parts of native vegetation that have become entwined with the vine. Pile thoroughly cleaned woody debris separately, and chip it for mulch.

Follow-Up

Some practitioners recommend revegetating immediately with low-growing species (if appropriate to your restoration project) in order to deter Cape ivy reinfestation. Return to the site as needed: more frequently for moist sites—approximately every 4–8 weeks—and perhaps as little as every 6 months for dry sites. Small Cape ivy plants can be hard to spot when growing in thick undergrowth and therefore easily overlooked, so check often. The strategy is to be responsive to regrowth and be persistent. Expect an eradication program to require 3–4 years when working on patches of less than an acre.

Interesting Facts

Native to South Africa, Cape ivy was introduced to the US during the 1850s as an ornamental, and has since been used in landscaping and possibly erosion control.

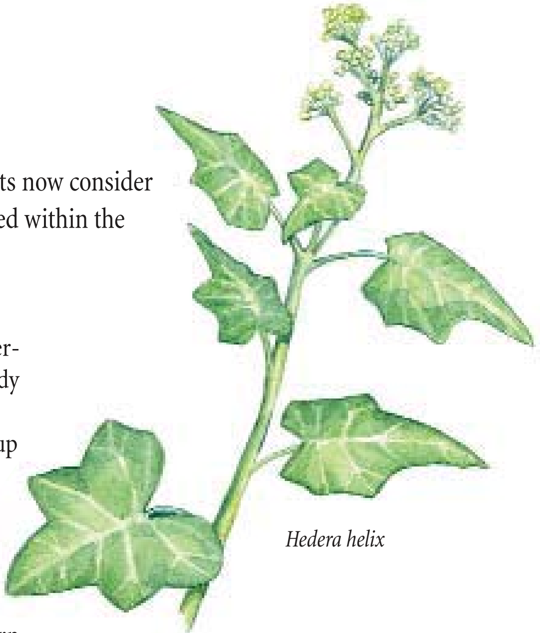
VINES

IVY SPECIES

English ivy ***(Hedera helix)***

Algerian ivy ***(Hedera canariensis)***

Ginseng Family (Araliaceae—some botanists now consider members of this family to be properly classed within the family Apiaceae.)



Hedera helix

Description

Both English and Algerian ivy are woody evergreen vines commonly found in moist, shady woodland areas.

Ivy grows as a vine and groundcover for up to 10 years before flowering. English ivy leaves are alternate, dark green, and leathery. They usually have 3–5 lobes, white veins, and aerial rootlets that secrete a sticky substance, enabling ivy to climb up tree trunks. Older plants capable of flowering can turn increasingly shrubby, with leaves that are more oval and measure 2–4 inches long. Algerian ivy is distinguished from English ivy by its 3-lobed leaves, pink to reddish stems, and white flowers.

Reproduction

In mature plants, terminal clusters of small, yellowish-green, and inconspicuous flowers appear in fall; blue-black berries appear the following spring.

English ivy spreads primarily by rhizomes, but it can also reproduce from seed. Seeds are disseminated by birds whose digestive tract scarifies the hard seed coat. Algerian ivy is a relatively new invader, so less is known about its reproduction. It is, however, reported to produce a large quantity of viable seed and to have a large root system.

Impact

Ivy vines form dense carpets of vegetation that can cover native vegetation as well as open soil. This dense groundcover can deprive native plants of light and nutrients and reduce germination of the native seedbank. Evenually even large trees can be killed by ivy climbing into their canopies. Algerian ivy is considered more invasive than English ivy because it is rapidly invading relatively undisturbed forest understories. The leaves and berries are toxic.

Key Factors

- Seed longevity not known, but reported to be quite viable.
- Shallow root system, but resprouts from cut roots (typically more than a half-inch) left in contact with the soil.

Treatment Options

Removing ivy can increase the potential for erosion on creek banks and slopes, so have an erosion control strategy in place prior to removal.

- **Pull** vines climbing into trees and along the ground by hand or with rakes and McLeods. Ivy can sometimes be rolled up like a carpet and piled or hauled off-site.
- **Cut** woody stems with pruners or loppers, and **dig** up the roots with a shovel to prevent resprouting.

- **Cut and treat** vines that are well established or climbing into trees. Make two cuts to remove a 12- to 16-inch section of the vertical stem. The portion of the vine remaining in the tree, without access to the roots, will eventually die. To prevent resprouting from the lower portion remaining in the ground, the stump can be treated with herbicide (some land managers use a 50 percent solution of glyphosate) or cut out with a Pulaski or shovel.

Disposal

Pulled ivy roots left in contact with soil may reroot. Piles may be left to decompose on a tarp on-site or hauled off-site and disposed of as green waste.

Follow-Up

Check for resprouts or new seedlings 3–4 times a year. These are easy to remove by hand. If piles are in contact with soil, check for rerooting and regrowth.

Interesting Facts

English ivy is native to Europe, was most likely introduced to the US as an ornamental in colonial times, and has been used to control soil erosion. Algerian ivy, as its name suggests, is native to northern Africa and southwest Europe. English ivy has been used since the time of the Ancient Greeks to treat a range of health complaints, including rheumatism, toothache, and even cellulite.

Notes

HIMALAYAN BLACKBERRY

Also known as Armenian blackberry

Rubus discolor

Rose Family (Rosaceae)

Description

This perennial shrubby vine is common in riparian woodlands, disturbed open areas, and along streams.

Himalayan blackberry forms mounds up to 10 feet tall, with arching or trailing, thorny stems that become woody and reach up to 40 feet long. These areas are often impenetrable. The canes (stems) are green to deep red, turning woody with age. The leaves are toothed or serrated along the edges and have a mat of fine hairs underneath that give a whitish appearance. Leaves on flowering stems have 5 leaflets. To distinguish Himalayan blackberry from the native species, look for hooked or curving thorns, 3–5 leaflets, and larger fruits that ripen later than the native blackberries. Native blackberry (*Rubus ursinus*) has just 3 leaflets and fine prickles rather than single thorns. Thornless elm leaf blackberry (*Rubus ulmifolius* var. *inermis*) is another invasive blackberry species to look out for. This species is thornless and produces no fruits, only flowers.

Reproduction

Himalayan blackberry reproduces in a variety of ways. It can spread vegetatively by rooting from the cane tips or from nodes along the canes, from rhizomes or root fragments, and from the root crown. Canes bear fruit in their second year and then die. Every year the crown produces new canes that replace the dead ones. White (or sometimes pinkish) flowers with 5 petals and many yellow stamens bloom from June to August. Bumblebees and honeybees pollinate the flowers. Edible berries ripen and turn black in August to September. Seeds are viable and tend to be dispersed by mammals or birds whose digestive tracts scarify the hard seed coating and promote germination. Seeds germinate in the spring and fall, but can remain viable for several years. An individual plant can live 25 years.

Impact

Once established, the plant's dense mounds displace native vegetation by shading out light. Individual canes are relatively short-lived (2–3 years), so a build-up of dead canes and abundant leaf litter gradually increases the risk of fire. Himalayan blackberry reduces access to water for wildlife, degrades pasture, and is sometimes a nuisance to recreationists seeking access to natural areas.

Key Factors

- Stout thorns necessitate the use of leather gloves and protective clothing.
- Abundant seed production.
- Seeds viable for several years.
- Fast-growing stems.
- Resprouts from the crown and root fragments left in the soil.
- Thrives in moist areas.

Treatment Options

- **Cut** stems with loppers close to the ground. **Dig** out rootball with a Pulaski or shovel, and remove as much of the root as possible. Interconnecting roots reaching over 30 feet long and 2–3 feet deep make pulling up *all* roots extremely difficult. Realistically, you should aim to remove the main rootball and the large lateral roots. Dense thickets and thorns also make working with blackberry labor-intensive and uncomfortable, so control may be feasible only in sensitive habitat or small infestations working from the outside in.

- **Brushcut** the canes; use McLeods to clear the vegetation. The best time to do this is when flowers are in bloom but before the fruit sets. Cutting encourages new growth but may be effective if repeated over a number of years.
- **Cut and treat.** Some practitioners cut stems to about 1 foot and treat stumps with 25–50 percent concentration of glyphosate immediately after cutting. Don't use herbicide on or near plants from which people may pick and eat the berries.

Disposal

Transfer stems and roots to a site where they can be left to decompose, making sure that all berries have been removed. Alternatively, burn the debris or trim it into pieces small enough for bagging and disposal.

Follow-Up

Regardless of the method used, follow-up is essential. Some land managers recommend immediate revegetation with quick-growing shrubs and trees, with periodic visits to the site to check for seedlings or regrowth. After you've removed the canes, one option is to hoe the soil or use a rototiller. This will clear out any roots, but is practical only for small infestations. Goats will also graze on younger plants.

Interesting Facts

Native to Eurasia, Himalayan blackberry was introduced to the US in the late 1800s as a cultivated crop. The berries make great pies and jams!

Notes

VINES

PERIWINKLE

Vinca major

Dogbane or Milkweed Family (Apocynaceae)

Description

Periwinkle is a spreading perennial vine most commonly found in shaded riparian and disturbed areas.

The leaves are opposite, 2–3 inches long, broadly oval in shape, and pointed at the tip. They are glossy, dark green, and have tiny hairs along the leaf margins and a waxy coating. Flowering stems grow erect to about 1.5 feet, while non-flowering stems become long and trailing. The plants can die back in hot, dry weather.

Reproduction

Periwinkle spreads vegetatively by arching stolons that root at the tips, and by vigorous underground growth of stolons. Like Cape ivy, it also roots from fragments of the stem. The roots are fibrous and form shallow-growing mats typically 6–12 inches below the soil surface. This weed can tolerate a range of soils; wet conditions trigger spurts of vegetative growth. Single, blue-purple, tubular flowers with 5 flattened petals bloom between March and July. It is not clear whether periwinkle can produce viable seed in California.

Impact

Periwinkle forms a dense carpet of both aboveground vegetation and matted roots that excludes native groundcover species and prevents seedlings of trees and shrubs from establishing. Periwinkle can also contribute to soil erosion along streambanks.

Key Factors

- Resprouts from root fragments (typically greater than a quarter-inch in diameter) left in the soil.
- Rapid growth.

Treatment Options

- **Pull** up the dense vegetation and underlying stolons using a McLeod. Pull the roots up from the base of the stems. If working in clay or dense soils, roots may break off, and follow-up grubbing may be required to ensure removal.
- **Pull** periwinkle by hand if it is a very small patch in sandy or loamy soil. Generally, this method only works if the roots are within 1–2 inches of the soil surface or if the soil is loose and very moist.
- **Brushcut** the vines close to the ground and then cover the area with weed fabric, black plastic, or cardboard. Leave for at least 1 year, possibly 2. Some practitioners use a combined treatment by cutting back the aboveground vegetation, grubbing out the roots, and then covering. Weed fabric is expensive and may be practical only for small infestations. You may want to consider using layers of cardboard or carpet instead.
- **Dig** a trench around the patch, 6 inches deeper than the stolons, and line it with fabric to temporarily contain periwinkle. This will prevent the root system from expanding until the patch can be further controlled.

- **Foliar spray.** Some practitioners report excellent results with spraying and no cutting. Others cut the plant close to the ground in spring when periwinkle is actively growing, using a brushcutter, scythe, or weed whip, and then, within 1 minute of cutting, spray a 2 percent solution of glyphosate onto the cut stems. The purpose of cutting the vines beforehand is to break up the waxy cuticle and improve absorption of the herbicide. Spring is the most effective time for this treatment.

Disposal

As with Cape ivy, it is important to remove any larger broken stems and root sections from the site as these will resprout. The cut vines can be piled on a tarp and left to decompose. Turn the piles periodically, making sure no stems come in contact with soil or water. Alternatively, bag the vines and dispose.

Follow-Up

Monitor the site at least every 3 months for resprouts, depending on how moist the site is. If you use landscape fabric, check that it is still held firmly in place, and pull up or grub out any escaped plants.

Interesting Facts

Native to Mediterranean Europe, periwinkle's use as a medicinal plant goes back hundreds of years. The leaves have traditionally been used as an astringent and to reduce hemorrhages, and magicians added them to love potions! It was probably introduced to the US as an ornamental.

Notes

BROOM SPECIES

French broom ***(Genista monspessulana)***
Scotch broom ***(Cytisus scoparius)***
Spanish broom ***(Spartium junceum)***
Legume or Pea Family (Fabaceae)

SHRUBS

Description

These three broom species are invasive shrubs that grow in grasslands, scrub, and woodland habitats. Once introduced, they can quickly colonize disturbed areas, trailsides, and streambanks, and sometimes spread into wildlands along roads. Broom species are somewhat shade tolerant, though in general Scotch broom is found in drier, sunnier locations. Individual shrubs have been known to live up to 17 years.

French broom usually grows 6 to 10 feet tall, but can grow as tall as 15 feet. Mature plants are evergreen, especially along the coast. Leaves grow in groups of three. Each leaf is about a half-inch long, or larger in shadier woodlands.

Scotch broom also grows 6 to 10 feet tall. Young plants are easily distinguished from French broom by the flowers (see below) and by the ridges on their dark green stems. Scotch broom leaves are smaller and fewer than French broom, giving the plant a wiry look.

Spanish broom is distinguished from the other types of broom by its smooth, round stems, single leaves, and large flowers. Leaves are shed during summer drought, giving a very stick-like appearance. Its taproot can reach depths of 6 feet, making Spanish broom the hardest of the three brooms to remove.

Reproduction

French broom flowers start to appear in March (earlier in sunny locations) and continue to bloom through May or even July. They are yellow, less than a half-inch in size, and have the familiar pea flower shape with banner, wing, and keel petals. The flowers grow from the main stem in bunches of 4 to 10. In June and July, inch-long fuzzy green seed pods appear, turning dry and brown in late summer. Each pod bears several to many shiny black seeds.

Genista monspessulana

Scotch broom flowers are similar to those of French broom, but they are larger and deeper yellow. Seed pods are similar, too, except that they have hairs only on their seams, instead of being fuzzy all over.

Broom seed pods, when ripe, burst open explosively and propel seeds up to 12 feet from the plant. Starting in the second year of growth, seed production is prodigious; in a single square-meter plot, researchers have counted more than 6,700 seeds! Furthermore, the seeds persist, remaining viable for at least 5 years and potentially for decades. Broom seeds often germinate with early winter rains, establishing a flush of new seedlings from December through July.

Impact

Dense stands of broom change the structure of the invaded plant community, often increasing fire hazards by creating a "ladder" of woody material that can carry fire into trees. Brooms provide poor forage for native wildlife. The leaves and seeds are toxic. As nitrogen-fixing legumes, they can enrich soil nitrogen, which in turn can promote the growth of other weedy plant species once the broom has been removed.

Key Factors

- Prodigious seed production.
- Seeds remain viable for many years, potentially decades.
- Resprouts from stumps and root crown when cut.

Treatment Options

- **Pull** shrubs by hand or with a Weed Wrench, or **dig** with a Pulaski, pick, or shovel between January and May, when the moist ground makes it easier to remove the roots, and before another generation of seeds has developed. Repeated pulling of successive generations is currently thought to be the single most effective method of removing broom.
- **Cut** shrubs to just above ground level using a pruning saw, loppers, or brushcutter, ideally during the dry season so that the stumps become more stressed. Cutting, rather than pulling, has the advantage of minimizing soil disturbance. Untreated cut stumps *will* resprout and must be cut repeatedly (see Follow-Up, below.) Alternatively, cut the stems about 2 inches above ground level, then **girdle** the stump by peeling the bark off the stems—like peeling a banana—down to ground level. This reduces resprouting and works best on medium to large French broom plants.
- **Cut** stems, using loppers, to about 2 inches above ground, and grub out the roots.
- **Cut and treat** the stumps with herbicide.
- **Girdle** the trunk of large broom plants with a small hand tool such as a paint scraper. (Warning: while girdling minimizes soil disturbance, standing dead broom will increase, not reduce, fire hazards. Also, broom left standing will be in the way when you return for follow-up.)
- **Scrape** seedlings with a hula hoe.
- **Flame** seedlings in monoculture with a propane torch (weed blancher). This is most effective and efficient when the seedlings have only their two seed-leaves, but can also work on seedlings with true leaves, up to a few inches tall. (See Follow-Up for more on flaming.)

Follow-Up

Wherever mature plants are removed, emerging seedlings will also have to be removed for *at least* the next 5–8 years and probably longer. In the first year after removing mature plants, the next generation will be too small to pull, but this dense flush of seedlings is effectively controlled by flaming with a propane torch. A single pass with the torch will wilt and kill seedlings. Controlling broom plants when they are seedlings will spare you a great deal of work in pulling plants the second year after removing mature broom.

Broom is not eradicated from your site until the seedbank is exhausted, so be vigilant to prevent subsequent generations from producing seed. Broom is easiest to spot when the bright yellow flowers are present, but be sure to remove it before the seed pods mature.

Broom resprouts from the base when cut: all except seedlings and old, senescent plants can resprout after cutting if not treated with herbicide. Resprouting stump shoots can be cut or weed-whipped the following year, either in late spring or in the dry season. Repeat this treatment annually until the plants' energy resources are depleted.

Disposal

Pulled plants that have not produced seed can be piled on-site to decompose. Alternatively, they can be hauled off-site and chipped or recycled as green waste. One innovative use of broom waste has been to bundle the pulled plants to create 8- to 12-inch wattles that can be secured to slopes to prevent erosion.

Plants that have gone to seed should be piled on tarps or bagged to reduce the number of seeds falling to the ground and germinating. Putting broom-with-seed piles in deep shade will also help inhibit germination. Tarps should be visited annually, and eventually removed when materials have decomposed.

Interesting Facts

French broom originates in the Mediterranean and was reportedly introduced to the Bay Area as an ornamental in the mid- to late 1800s. Scotch broom is native to much of Europe and the foothills of North Africa.

Notes

Notes

SHRUBS

SHRUBS

COTONEASTER SPECIES

Cotoneaster franchetii
Cotoneaster pannosa
Cotoneaster lactea
Rose Family (Rosaceae)

Description

Cotoneasters (pronounced co-TONE-e-aster) are evergreen shrubs that grow in grasslands, shrublands, forests, and open areas, and can form dense thickets.

They are either sprawling or erect to about 10 feet tall. The branches criss-cross one another. The leaves are simple, elliptic-ovate, dark green to gray-green, and hairy beneath. They grow up to three-quarters of an inch long. The leaves of *C. lactea* are larger.

Reproduction

Clusters of white to pink 5-petaled flowers bloom between June and September, followed by showy crops of orange or red berries September through February. Seeds are produced in great numbers and do not require fertilization. They drop near the parent plant but are readily eaten by many bird species, which increases the distance over which seeds can be dispersed. Seeds germinate during the rainy season. Cotoneaster can also spread vegetatively by root sprouting and by branches rooting at the nodes.

Impact

Cotoneaster is thought capable of invading intact ecosystems, where it competes with native vegetation for water, nutrient, and light resources. This is seen particularly in plant communities where the native toyon (*Heteromeles arbutifolia*) is found. The root system grows rapidly, making removal difficult. In addition, the dense shrubs frequently grow under trees and can facilitate the spread of fire by forming a fuel ladder.

Key Factors

- Produces many stump sprouts after cutting.
- Root system is extensive and difficult to remove.
- Abundant seed production and bird-dispersed fruits.
- Seed longevity is not known, but may be several years.

Treatment Options

- **Pull** seedlings a half-inch or less in diameter with a mini-Weed Wrench or by hand. Pulling is practical for small plants only, as cotoneaster develops multiple stems from a large root mass, making it difficult to grasp the base.
- **Cut and treat.** Cut stumps close to the ground during the fall and winter. Practitioners using herbicides apply a 50 percent concentration of glyphosate to the stumps. Painting stumps with glyphosate is effective on large shrubs

but becomes more difficult on the smaller ones, as the many small stems can be hard to see. For smaller plants, it may be preferable to spray the herbicide.

- **Cut and cover.** Remove all branches of mature shrubs with loppers or a pruning saw, then cut the trunk back to about 1 foot in height. If you cut much shorter, the plant may produce a significant number of sprouts from the root and trunk. Recommendations vary on when to cut, but research suggests cutting just after the shrub has produced fruit (when its energy reserves are at their lowest) but before fruit has dropped, thus minimizing the risk of mature berries germinating. Cover stump and surrounding ground (1–2 feet all the way around the stump) with landscape fabric for at least a year.

Follow-Up

Return to the site at least once a year to check for resprouts and seedlings. If you use landscape fabric, check periodically that it hasn't been moved by animals or hikers. You can also remove the fabric twice a year to cut back any growth that has resulted despite the lack of sunlight. Make sure you reposition the fabric securely.

Disposal

Individual plants can be piled on-site. For larger infestations you might want to chip the debris.

Interesting Facts

Native to China, cotoneaster was introduced to the United States as an ornamental most likely during the mid- to late 1800s.

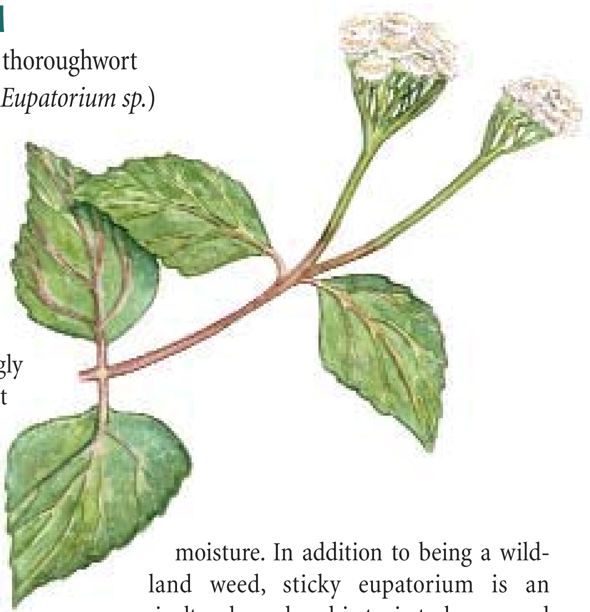
Notes

STICKY EUPATORIUM

Also known as Crofton weed, eupatory, thoroughwort

Ageratina adenophora (formerly *Eupatorium sp.*)

Sunflower Family (Asteraceae)



Description

This perennial herb or semi-shrub is found on moist, exposed slopes and disturbed areas, particularly in riparian habitat and in forest clearings.

Sticky eupatorium often has a straggly appearance and typically grows 3–5 feet tall. The stems are long and dark red with downy hairs, and woody at the base. Sticky eupatorium grows rapidly, its shoots and branches forming dense thickets. Leaves are opposite and triangular-ovate with toothed margins. They are about 2 inches long, dark green, and glossy.

Reproduction

Sticky eupatorium spreads primarily by asexual seed production. Small, white or pinkish inflorescences resembling pincushions appear in terminal clusters in March. From April to mid-June each plant produces 7,000–10,000 tiny black seeds, although up to a third of these are not viable. Each seed is topped with fine hairs that aid in wind dispersal. The seeds are easily airborne or dispersed by water, but they can also stick to clothing, footwear, or passing vehicles and animals. Most germination takes place in August and September, and seedlings are capable of reproducing vegetatively within 8 weeks of germination. The plant can also reproduce from the roots and through parts of the stem that touch the ground.

Impacts

Sticky eupatorium crowds out native plants after fire disturbance or flooding, and is very competitive with natives in areas with summer moisture. In addition to being a wildland weed, sticky eupatorium is an agricultural weed and is toxic to horses and unpalatable to cattle.

Key Factors

- Prolific seed production and rapid growth.
- Seed viability thought to be 2–3 years.
- Thrives in moist drainage areas.
- Resprouts from roots and from stems in contact with soil.

Treatment Options

- **Pull** plants by hand or **dig** them out with a Pulaski when the plant is in flower but before it has gone to seed. Removing sticky eupatorium by hand is time-consuming. Although the root system is shallow, stems break easily, especially on drier soils, so care should be taken to pull from the base of the stems so as not to leave root fragments. In moist drainage areas, you might find yourself pulling up heavy, sodden clumps of root mass and soil. Often you'll find that the roots form a continuous mat. However, it's important to get the root mass, as the plant will otherwise resprout.

- **Brush cut** sticky eupatorium on dry, steep slopes and in drainage areas, using a rotary slash brushcutter. Some practitioners then follow up by digging out the roots; others, by spraying the cut stems with herbicide. In the Marin Headlands repeated brushcutting at monthly intervals in the drier months has proved unsuccessful in exhausting the root system and preventing the stems from resprouting, perhaps because of the additional moisture supplied by summer coastal fog.
- **Foliar spray.** Some practitioners have have had success by spraying a weak solution of glyphosate in infestations on dry slopes away from water. Spray the tops and undersides of the leaves (either before or just after the plants begin to show buds).

Disposal

Stems will easily reroot in water, so make brush piles well away from wet areas. Piles can be left to decompose on site.

Follow-Up

If the infestation is a manageable size, follow brushcutting with removal of the roots. Alternatively, if it is safe to use herbicide, you can wait for lush growth to return after brushcutting and spray the plants in order to finally kill them. Return to the site 2–3 times after the initial visit (at 6-month intervals) to scrape off any new seedlings from the soil surface with a McLeod or hula hoe. Mulching the weeded area with a 1- to 2-inch-thick layer of straw or covering with landscape fabric will help prevent the seedbank from germinating and will make follow-up much easier.

Interesting Facts

Originating in Mexico, sticky eupatorium is considered a major agricultural weed around the world. It may have been introduced to California as an ornamental plant. In India the plant is being used to produce a green commercial dye, while in Nepal the plant juice is applied to cuts and injuries. Studies show that composting sticky eupatorium for approximately 2 months eliminates its toxins.

Notes

ARTICHOKE THISTLE

Also known as cardoon, wild artichoke

Cynara cardunculus

Sunflower Family (Asteraceae)

Description

Artichoke thistle is a perennial herb commonly found in disturbed grasslands where it can form dense stands. It also invades chaparral and riparian woodland habitats.

Growing up to 5 feet tall, its erect stems are thick, coated with downy hairs, and ribbed like celery. The leaves are silvery or grayish-green on the upper surface, and whitish beneath due to the presence of white hairs. The leaf margins have one-eighth to one-quarter inch spines. The leaves form a basal rosette.

Reproduction

Artichoke thistle reproduces primarily by seed but can also resprout from the roots if cut back. One or more flower heads bloom at the tip of stems from April to July and are pollinated by bees. Occasionally flowering occurs in the first year, but more often in the second. One plant can produce up to 15 or so flower heads (or cardoons) with pinkish-purple or blue flowers. A single flower can produce hundreds of seeds. The seeds are brown to black, roughly a quarter-inch long, and have feathery bristles at the tip. Being too large and heavy to travel far by wind, the seeds generally drop near the parent plant. Seed that has travelled farther afield is usually spread by birds, animals, and water. Research suggests that seeds remain viable up to 7 years.

Impact

Artichoke thistle competes with neighboring vegetation for moisture and nutrients, and once established will shade out other plants to form monocultures. Thick stands of the plant inhibit the movement of wildlife. The plant is not poisonous but may injure grazing livestock and humans who come into contact with it.

Key Factors

- The spines necessitate wearing heavy leather gloves, long sleeves, and even protective clothing such as chainsaw chaps when removing this plant.
- Abundant seed production.
- Seed longevity reported to be at least 5 years.
- Prolonged germination period (from first rains to as late as July).
- Resprouts vigorously from deep taproot (up to 8 feet deep).

Treatment Options

- **Pull** or **dig** plants out. In theory, most of the taproot needs to be removed to prevent resprouting, but some land managers have been able to kill artichoke thistle by digging up only 12–18 inches of the root. The taproot's brittleness may make removal difficult, so pulling during the rainy season is best.
- **Cut** and bag flower stems before they open, to reduce seed production if you do not have time to remove plants. Some practitioners have also found grazing by goats helpful in reducing seed spread.

- **Cut and treat.** Some weed workers using herbicide prefer to apply it to the base of a cut plant rather than covering the large leaves. They cut the stems close to the base with loppers and apply herbicide to the base.
- **Brush cut** every 3 weeks between December and March, and then every 4 weeks until the plants died during the summer drought. For heavily infested areas, a tractor with an attached flail mower has been used.
- **Foliar spray.** Seedlings may need to be sprayed just once, but larger plants may require 3–4 sprays in one season. Some practitioners spray as plants begin to bolt (at the end of the first year of growth).

Disposal

Seed heads should be disposed of (if flowers are developed or seeds are present, place in plastic bags), together with any roots, and taken offsite. It's important to destroy as much of the root system as possible, either by herbicide or physical removal and proper disposal.

Follow-Up

Return periodically to the site to check for seedlings coming up from the seedbank. Some have also carried out surface tilling as a follow-up treatment after mowing or brushcutting.

Interesting Facts

Native to the Mediterranean, this plant was introduced to the US in the mid-1800s for use as a vegetable (the inner leaf-stalks, taproot, and base of the flower head are edible). It is related to the commercially grown globe artichoke (*Cynara scolymus*), and the two will hybridize. The commercial variety of cardoon has fleshier flower heads, and the leaf lobes and inner flower bracts are without spines.

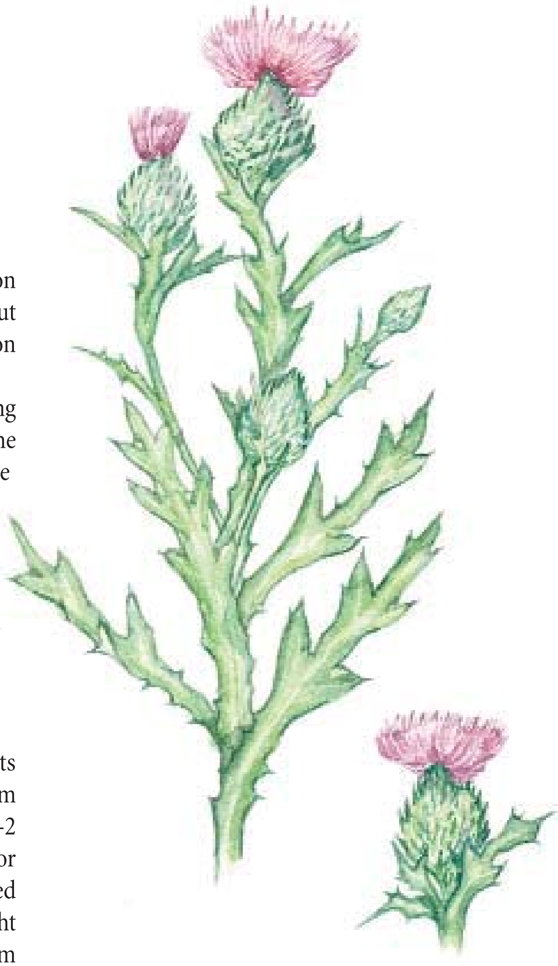
Notes

BULL THISTLE

Also known as spear thistle

Cirsium vulgare

Sunflower Family (Asteraceae)



Description

Bull thistle is a biennial commonly found on recently disturbed sites and forest clearings, but it also invades native grasslands. It thrives on moisture.

Bull thistle's erect spiny stems and spreading branches reach 2–5 feet. The upper surface of the leaves is grayish-green with short, stiff hairs; the undersides are a woolly gray. The leaves are alternate, stout, and have a winged appearance, with pointed lobes and a long yellow spine at the tip. Bull thistle produces a rosette of low-growing leaves in the first year. A fleshy taproot can grow up to 30 inches long.

Reproduction

Bull thistle reproduces solely by seed. It bolts and flowers generally in the second year, from June to September. Flowers are terminal, 1.5–2 inches across, and rose-colored to magenta or purple. The base of the flowers is cone-shaped and densely covered with green spines. Light brown, oblong seeds are ripe for release from July to October. Each plant produces seed only once before dying, but can produce thousands of seeds. The seeds are wind-dispersed, although research suggests that most drop within a few feet of the parent plant. Seeds germinate in spring and fall.

Impact

Bull thistle can establish in grassland and scrub habitats, quickly colonizing open patches. It also reduces the value of forage lands.

Key Factors

- Spines necessitate the use of heavy leather gloves when working on this plant.
- Copious production of wind-dispersed seeds.
- Seed longevity thought to be at least 10 years.
- High germination success rate.
- Resprouts from taproot unless removed from below crown.

Treatment Options

- **Pull** bull thistle by hand before the flowers open. To spare yourself the spines, step on the stem so that the thistle leans over to one side before you bend down to pull it. If the ground is hard, loosen the soil with a pick and then pull up as much of the taproot as possible. Clip any flower heads that are beyond the bud stage if population size is small.

- **Cut** the stems to at least 1–2 inches below ground with a sharp-edged shovel before the flowers bloom. Remove flower heads when feasible, i.e., in small populations. The plant may continue resprouting if the root is left in the ground, so follow-up is important.
- **Mow** after the thistles have bolted but before they flower. A second mowing one month later is usually necessary. Thistles must be cut close to the ground. Yosemite National Park has had some success using this technique.

Disposal

The stems can be left to decompose on-site. Any clipped flower heads should be removed (and bagged, if plants are on the cusp of developing seed), as thistle flowers can mature and produce viable seed even after being cut off the stem.

Follow-Up

Not all bull thistles flower in the second year, so follow up for several years to catch those plants still in the rosette stage. Dig up rosettes each year or chop out 1–2 inches below ground. Replanting the area with native species will discourage bull thistle, which thrives more on open, exposed sites with little competition from other species. There is also evidence to suggest that bull thistle does not tolerate deep shade, so you might have success using a weed fabric barrier in dense patches as a follow-up treatment. Clean equipment before leaving the infested site to prevent the spread of viable seed.

Interesting Facts

Bull thistle is native to Europe, western Asia, and North Africa, and reached the United States as a crop seed contaminant during the colonial era. The taproots at the rosette stage are edible if cooked.

Notes

FENNEL

Foeniculum vulgare

Carrot or Parsley Family (Apiaceae)

Description

Fennel is an erect perennial herb commonly found in annual and perennial grasslands, open, disturbed areas, chaparral, and along watercourses and roadsides.

Fennel grows 4–10 feet tall and smells like licorice. The branching stems are stout, grayish-green, and marked with long vertical grooves. The stems are jointed and sheathed by leaves at the nodes. The leaves are dissected into fine, feathery strands like dill leaves, with each division measuring up to 5 inches long. Fennel has a stout taproot.

Reproduction

Fennel reproduces by seed and, after cutting, by regenerative root crowns. Flowers first appear 1.5–2 years after germination. Small, yellow flowers in umbrella-shaped clusters (umbels) bloom between April and August. Aromatic seeds are produced in pairs during summer until September. These are light green to brown, flattened and ribbed, measuring a half-inch long. Within 2 years, one plant can produce over 100,000 seeds. Seeds are commonly spread by water, or by coming into contact with clothing, animals, vehicles, and machinery. Seeds will germinate at almost any time of the year. Soil disturbance may trigger higher rates of germination.

Impact

Fennel can form dense monospecific stands by competing with other plant species for light, water, and soil nutrients. Research suggests it may also have an allelopathic effect on other species.

Key Factors

- High seed production.
- Seeds remain viable in the soil for several years.
- Resprouts from roots when cut.
- Mowing can stimulate increased growth if performed too early in growing season.
- Seedlings need light to grow.

Treatment Options

- **Pull** small seedlings by hand when soil is soft and moist. You can also use hand tools, such as a soil knife or trowel, to uproot seedlings. A thick taproot frequently makes pulling mature fennel impracticable.
- **Dig** out individual plants with shovels, hand picks, and Pulaskis, preferably when the soil is still moist. If you cannot get the whole root, remove the upper portion of the root crown (generally the top 3–6 inches). Cutting into the root just before the plant sets seed reduces the number of resprouts. If you don't plan to

follow up with herbicides, dig only in light infestations, because the soil disturbance will expose seeds and increase germination. The deep taproot and bulb store the plant's energy and will regenerate quickly if cut. Cutting alone will not kill fennel, so follow up on resprouts frequently to exhaust the roots.

- **Mow** fennel 4 times a year, about every 3 months, beginning in March–April. Some seed heads lie prostrate and are therefore easier to miss. Mowing *during* seed set encourages seed spread and should therefore be avoided. Mowing too soon before seed set appears to increase vegetative growth. Reports suggest that this repeated mowing technique can eradicate fennel within 4 years.
- **Mow and Foliar spray.** Some weed workers mow fennel and wait for resprouts to appear, then apply glyphosate to the bushy resprouts.
- **Foliar spray.** A 2 percent solution of glyphosate can be sprayed on the leaves of green seedlings emerging after dormancy (March–May). Spray before the plant bolts (around June). Repeat application may be needed. For fennel growing near water, use a suitable glyphosate product.

Follow-Up

Remove any ripe seeds from the site by brush-cutting and bagging the flower heads. This is also a useful stop-gap measure to contain the spread of fennel on sites where elimination is not possible. In chaparral, revegetate with native shrubs immediately to discourage fennel from re-establishing and prevent colonization by other invasive species. Check for seedling growth twice a year, particularly in late winter/early spring, and follow up on resprouts to exhaust energy stored in the roots.

Disposal

Fennel stalks without seed heads can be piled or even composted in large piles on site.

Interesting Facts

Fennel originally comes from the Mediterranean region where the seeds and tuberous roots have been used in cooking at least since the Roman era. There is little information on its introduction to California, but it most likely escaped from cultivation. In medieval times, the seeds were eaten to suppress the appetite, while the raw bulb is still eaten as a digestive in southern Italy. Wild pigs will forage for the roots, which furthers invasion through soil disturbance, while birds and rodents reportedly eat the seeds. Fennel is attractive to Anise Swallowtail butterflies as a source of nectar, but generally speaking, fennel tends to displace other animal species by reducing habitat diversity.

Notes

PERENNIAL PEPPERWEED

Also known as tall whitetop

Lepidium latifolium

Mustard Family (Brassicaceae)

Description

This versatile, rapid-growing perennial herb forms dense stands, commonly in or adjacent to salt marshes and freshwater riparian areas as well as hay meadows and even roadsides.

An erect and branching plant, perennial pepperweed reaches 3 feet or taller in moist conditions. The alternate leaves are lanceolate, toothed or smooth-edged, typically gray-green, and waxy; lower leaves are larger. The thick roots look like weedy parsnips and grow to a length of 10 feet, making removal extremely difficult. Pepperweed often grows near and is confused with Grindelia. Grindelia stems are reddish, while pepperweed stems are not.

Reproduction

Perennial pepperweed spreads primarily from underground roots, in addition to root fragments, which can float in water for long periods and still sprout. It also spreads from abundant seeds, with a single plant producing thousands of seeds each year. Tiny, white 4-petaled flowers bloom in terminal clusters from June to September. The seed pods, maturing in August and September, are tan to red-brown, rounded, slightly hairy, approximately 1/16 inch long, and bear 2 tiny, flattened seeds. Seeds are dispersed by water, machinery, and passing animals or people. Their longevity is not known, but is probably no more than 2 years.

Impact

Pepperweed tolerates salty soils and can invade intact ecosystems. A vigorous root system allows it to compete for water and nutrients with native species, such as pickleweed, which the threatened salt marsh harvest mouse requires. Pepperweed also degrades habitat for the California clapper rail. The woody stems can shade out sunlight needed for growth. The roots of pepperweed do not hold the soil well and allow increased erosion on riverbanks after flooding. Pepperweed is also an agricultural weed of hay meadows and is toxic to horses.

Perennial pepperweed is considered one of the most difficult invasive plants to remove. If you see a new infestation, act immediately! Most non-chemical methods are reported to have little impact on controlling this weed once it has become established.

Key Factors

- Large, deep, and vigorous perennial root system.
- Resprouts from small root fragments (of less than an inch) left in the soil.

- Produces thousands of tiny, viable seeds, although they appear to be short-lived.
- Accumulates thick layer of debris.

Treatment Options

- **Pull** plants by hand, preferably when the soil is moist and loose, and grub out as much of the root as possible. Hand pulling is feasible only for seedlings of young infestations. There are no easily pulled individual roots, but a continuous mass of deep, interconnecting roots that frequently break. Mechanical removal is not recommended given the plant's ability to spread easily from root fragments, but it will temporarily stop seed from spreading.
- **Cut and cover.** It may be possible to cut this plant back prior to flowering, and then cover the root system with cardboard or landscape fabric to reduce the plant's ability to resprout, though it may be difficult to hold the covering in place along shorelines.
- **Mow** or **brush cut** plants close to the ground when flower buds appear. (Removing only the top growth will stimulate regrowth.) Let the pepperweed grow back and bud again, then mow a second time. Some practitioners have followed this by immediately applying a 2 percent solution of glyphosate to the cut stems. *Note:* glyphosate is not reported to be effective as a foliar application (skipping the step of mowing or brushcutting) because the leaves have a waxy coating. In riparian or wetland habitat, use a suitable glyphosate product—one that is not toxic to aquatic organisms—and apply with a wick-type applicator to prevent herbicide drift.
- **Graze.** Sheep and goats will graze on perennial pepperweed if the leaves are still young and there is nothing else to eat.

Disposal

Keep roots away from waterways to minimize further infestations downstream. Wash equipment and the tires and undersides of vehicles after leaving the site. Bag and dispose of pulled plants as household garbage or take them to a green waste facility. Alternatively, dispose of the plants through hot compost with grinding (but not ordinary compost, as very small fragments will reroot).

Follow-Up

Regular follow-up is essential as the roots can lie dormant underground for several years. Return to the site in early spring and late summer to check for regrowth and to remove rosettes. Scrape litter from the soil surface to allow other species to grow. Soil remediation may be required before planting native species. Any revegetation should be carried out as soon as possible. Natives with creeping perennial roots may be best.

Interesting Facts

Perennial pepperweed is thought to originate in southwest Asia and to have spread to Europe many centuries ago. It came to California sometime in the 1930s, possibly as a contaminant of shipped seed. It seems likely that in ancient times the young leaves were served as a spicy salad green. In medieval Britain the seeds were "poor man's pepper" and the roots were a substitute for horseradish. Perennial pepperweed has been used to treat medical conditions such as skin disorders and painful joints, and may contain insecticidal properties. The flowers are still used in dried flower arranging.

POISON HEMLOCK

Conium maculatum

Carrot or Parsley Family (Apiaceae)

Warning! Poison hemlock can kill humans if eaten and may cause dermatitis, nausea, and headaches if touched or inhaled after continual cutting or mowing!

PERENNIALS & BIENNIALS

Description

Poison hemlock is an erect biennial, sometimes perennial, related to fennel, often found in scrub, riparian areas, and wetlands, as well on open slopes, disturbed sites, and roadsides.

Poison hemlock grows from seed to a rosette in the first year, then develops tall stems and flowers in the second year. It generally reaches 3–8 feet in height. The stalks—resembling fennel—are tall, ribbed, hollow, and sometimes purple-spotted. Leaves are opposite, pinnately compound, triangular, and bright green. The foliage, when crushed, has an unpleasant odor. Unlike wild carrot (Queen Anne's lace), poison hemlock has no hairs on its leaves and stems.

Reproduction

Poison hemlock reproduces by seed only, with each plant producing roughly 1,000 of them. Small, 5-petaled, white flowers appear in umbels mainly in June–July, although there are reports of poison hemlock flowering almost year-round in the East Bay. Fruits generally set in August–September. The seeds are spread most effectively by birds, animals, and water, but passing machinery and vehicles also aid seed spread. Dispersal occurs between September and February, and germination takes place from late summer to early spring.

Impact

A fast-growing species, poison hemlock can reduce native plant cover by shading other species. It is poisonous to wildlife and can cause paralysis and death in livestock.

Key Factors

- Poison hemlock is toxic to the skin and respiratory system, so wearing gloves and a mask is advised. One recommendation is to take frequent 5-minute breaks because of the potential for irritation. Some people feel ill even with protective gear!
- Usually a biennial, so no need to remove entire root system.
- Seeds are thought to be viable for up to 5 years.
- Grows best in rich soils in moist conditions.

Treatment Options

- Practitioners have reported difficulty in removing large stands of poison hemlock by hand and have tended to focus on small infestations. Some practitioners advise removing hemlock before seed set, while others remove poison hemlock year-round.

- **Pull** plants by hand, preferably during the rainy season when moist soils allow you to get more of the root. (You can use a soil knife or trowel to minimize direct handling of the plant.) Large clumps can be dug with a shovel.
- **Cut** using a hand pick to hit below the root crown and remove the upper portion (as opposed to the whole root).
- **Mow** to height of 3–4 inches in early April and then repeat a month later to follow up on any regrowth and new seedlings. Repeat for several years. Mowing won't eradicate poison hemlock, but it will help reduce the size of infestations by weakening the plant. It can deplete the seedbank if pursued regularly.

Follow-Up

Some practitioners have reported little success with mulching in areas where plants have been pulled, as large seedlings can bolt straight through. Others recommend laying a thick mulch (about 4 inches deep). Follow up on any regrowth, pulling seedlings by hand or with hand tools. Flaming with a propane torch during the rosette stage is another technique that deserves experimentation.

Disposal

Cut vegetation may be left on-site. However, cut and wilting hemlock plants can be palatable to wildlife and yet remain poisonous. Some attention to disposal or fencing may be necessary to protect deer and other animals.

Interesting Facts

Native to Europe, West Asia, and North Africa, poison hemlock was introduced from Britain as an ornamental in the late 1800s. It is a plant traditionally associated with European witchcraft. The Ancient Greeks used poison hemlock to execute political prisoners, including Socrates.

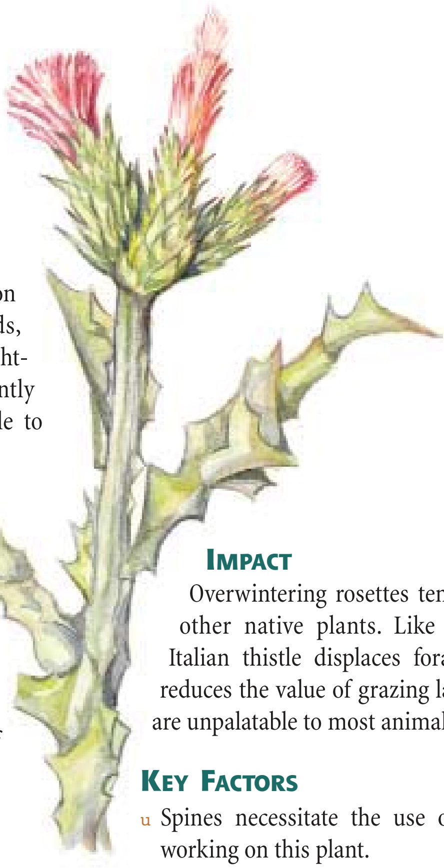
Notes

ITALIAN THISTLE

Also known as slender thistle

Carduus pycnocephalus

Sunflower Family (Asteraceae)



Description

Italian thistle is commonly found on disturbed sites, annual grasslands, pastures, and riparian areas. Drought-stressed, overgrazed, and frequently disturbed sites are more vulnerable to Italian thistle invasion.

Italian thistle is a winter annual or biennial broadleaf plant. It grows 1–6 feet tall and has erect, spiny-winged stems. The leaves are lanceolate, up to 6 inches long, and pinnately divided, with a spine at the tip of each lobe and the largest spine at the tip of the leaf. The stems and leaf undersides have a cobwebby down.

Reproduction

From September to December, pink to purple (but rarely white) flowers bloom in composite inflorescences borne terminally in clusters of 2–5. Italian thistle inflorescences measure only a half-inch across, smaller than those of bull or artichoke thistle.

Italian thistle reproduces only by seed. Inner (disk) seeds are cream-colored, sticky at first, striped, and have bristles. Outer (ray) seeds are yellowish to brown, smooth, and have no bristles. Most disk seeds are wind-dispersed and can travel several hundred feet. Disk seeds also have a thin gummy coating, which allows them to attach to animals and machinery. The germination rate is high, and germination typically takes place in the fall. Ray seeds generally remain in the flower head until it drops. These seeds persist in the soil for up to 10 years.

Impact

Overwintering rosettes tend to shade out other native plants. Like many thistles, Italian thistle displaces forage plants and reduces the value of grazing land. The spines are unpalatable to most animals.

Key Factors

- Spines necessitate the use of gloves when working on this plant.
- Very high seed production.
- Seed longevity up to 10 years.
- High germination rate.
- Resprouts from root portions left in the soil if not cut below root crown.

Treatment Options

- Unless you have a lot of volunteers to help, controlling Italian thistle by hand methods (pulling, digging, cutting) may be feasible only for small infestations. Digging is reported to be effective at killing Italian thistle, but will cause considerable soil disturbance, often resulting in seed germination or recolonization.
- **Pull** individual plants by hand once the flowering stems have bolted but before flowers are produced.

- **Dig** the plants out with a pick or shovel.
- **Cut** just below the crown with a small pick or trowel. This is a useful option in summer when the ground is too hard for pulling stems by hand.
- **Brush cut** or **weed whip** before the thistles begin to flower. Repeat the treatment into early summer to ensure energy reserves have been reduced.
- **Graze.** Sheep and goats will graze on thistles, especially in the early spring when they have reached 4–6 inches in height. Graze the animals for roughly 2–3 weeks in large numbers.
- **Foliar spray.** Some practitioners apply glyphosate to the plants before they go to seed, generally around mid-spring.

Disposal

Seed heads should be removed from the site and bagged or burned. The stems can be composted.

Follow-Up

Whichever treatment you choose, return to the site at least twice a year for a period of several years to monitor seedling growth and prevent further seed production.

Interesting Facts

Native to the Mediterranean, Italian thistle appeared in California in the 1930s, but it is not clear how it was introduced.

Notes

MUSTARD SPECIES

Black mustard ***(Brassica nigra)***
Field mustard ***(Brassica rapa)***
Mustard Family (Brassicaceae)

Description

Black mustard and field mustard are annual or biennial herbs that can reach up to 6 feet tall. The leaves are slightly hairy. The taproot is white and fleshy in maturity.

Reproduction

Mustards produce bright yellow, 4-petaled flowers from March to June. The small seeds are brown to black.

Impact

Mustards grow profusely and reportedly produce allelopathic chemicals that inhibit germination of native plants.

Treatment Options

See wild radish, below.
Note: Mowing is reported to be ineffective at eradicating mustard.

Interesting Facts

Both mustard species are thought to be native to Eurasia, where they have been in cultivation for thousands of years. Black mustard may have been introduced to the US as a contaminant of cereal grain. Field mustard is the wild ancestor of turnip, and its roots are often fed to livestock. Mustard greens are highly nutritious, and have been used in traditional medicine for cancer. The flowers are edible but may be allergenic to some people.

Brassica rapa

WILD RADISH SPECIES

Cultivated radish or wild radish ***(Raphanus sativus)***
Wild radish ***(Raphanus raphanistrum)***
Mustard Family (Brassicaceae)


Raphanus sativus

Description

These two radish species are herbaceous annuals (sometimes perennials) that frequently invade grasslands and open, disturbed areas, including roadsides. Wild radish, *Raphanus raphanistrum,* may also be found in wetland areas.

Although both species grow wild and both are commonly called wild radish, *Raphanus sativus* is the (escaped) cultivated plant, while *R. raphanistrum* is its wild relative. (S*ativus* means "cultivated" in Latin.)

Both species can grow to 3 feet or taller. The plants are erect, with branching stems that typically give mature plants a bushy appearance. The leaves are alternate, with lower leaves pinnately compound.

Reproduction

Raphanus sativus has 4-petaled flowers that range from white to pink, and bloom mostly between April and June, or almost year-round in the East Bay. *R. raphanistrum* has 4-petaled pale yellow and white flowers with dark veins, and blooms later in the year. The flowers are pollinated by bees and butterflies. Seed pods (siliques) are dark green or occasionally dark red, ribbed, and either smooth or downy. *R. sativus* may have only up to 5 seeds per pod, but *R. raphanistrum* pods contain up to 10 seeds. The seeds are dark, oval, and hard.

Wild radishes reproduce only by seed. Seeds can remain viable for at least 5 years and reportedly up to 20 years. Seeds are generally wind-dispersed, but are also spread by water and machinery. Germination takes place in spring and fall.

Impact

Wild radishes are capable of excluding native plant species. Both radish species are also agricultural weeds. *R. raphanistrum* seeds in large quantities may be poisonous to livestock.

Key Factors

- High seed production.
- Long seed dormancy.

Treatment Options

- **Pull** individual plants by hand or with a Weed Wrench before seed pods develop. Given the stout taproot, it's best to do this after a heavy rain. The taproots in mature plants make hand removal more difficult.
- **Cut** plants below the root crown with a pick or shovel before seed pods develop.

- **Mow** or **brush cut** wild radish if it covers a large area. It's important to do the first mowing before any seed pods develop. Mow as close to the ground as feasible, as the plants often resprout.
- **Foliar spray.** Some weed workers spray a 1 percent solution of glyphosate on the leaves before the plant flowers. However, wild radishes are reportedly developing resistance to several herbicides. Glyphosate application might best be reserved for follow-up spot treatment.

Disposal

Plants with seed should be bagged and removed from the site whenever feasible or composted on-site in a small area that will be maintained (for example, by follow-up weeding). Plants without seed can be left to decompose on-site.

Follow-Up

Given the high seed production and long seed viability of wild radishes, it is important to return to the site several times a year to check for seedling germination.

Interesting Facts

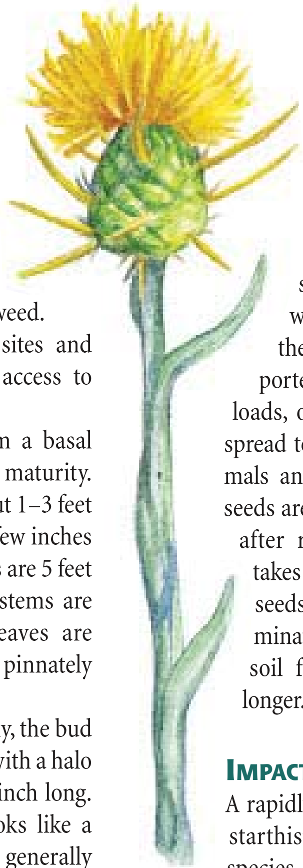
Radishes are native to the Mediterranean.

Notes

YELLOW STARTHISTLE

Centaurea solstitialis

Sunflower Family (Asteraceae)



Description

This winter annual (or sometimes biennial) is considered to be California's worst rangeland weed. It is also found on disturbed sites and annual grasslands, and affects access to recreation areas.

Yellow starthistle plants form a basal rosette as juveniles, then bolt in maturity. Flowering plants are usually about 1–3 feet tall, though some may be only a few inches and single-stemmed while others are 5 feet tall and branching. Leaves and stems are downy and gray-green. The leaves are alternate, 2–3 inches long, and pinnately lobed with triangular tips.

The flowers develop terminally, the bud appearing like a small scaly ball with a halo of stiff yellowish spines up to 1 inch long. The composite inflorescence looks like a fuzzy ball of tiny petals. Flowers generally bloom from May to September, but in the Bay Area a few plants bloom at any time of year.

Reproduction

Yellow starthistle reproduces solely by seed. The plants produce two kinds of seeds: plumed and plumeless, both measuring roughly a quarter-inch. Most seeds are plumed with a tuft of soft, white bristles that aid in wind dispersal. These seeds are pale (cream to tan) and develop on the inner (disk) part of the flower. The plumeless, outer (ray) seeds are darker brown. They remain attached to the flower head until it drops on the ground.

Large plants can produce as many as 1,000 composite flower heads which together can produce almost 75,000 seeds in a single season. Most seeds are wind-dispersed, but they spread the greatest distance by being transported in contaminated hay or seed loads, or attached to vehicles. They are spread to a lesser degree attached to animals and humans. About 90 percent of seeds are ready to germinate immediately after release. Germination frequently takes place after the first fall rains, as seeds need moisture and light to germinate. Seeds can remain viable in the soil for 3 years and possibly much longer.

Impact

A rapidly growing taproot enables yellow starthistle to outcompete native plant species, including purple needlegrass, for summer soil moisture. Yellow starthistle may also produce allelopathic compounds that give it another competitive edge. The current level of infestation in California (estimated at 22 million acres) has brought agricultural and economic loss by reducing the quality and yield of forage. It can be fatally poisonous to horses and its spines deter other livestock from grazing.

Key Factors

- High seed production.
- Seed longevity is at least 3 years.
- Fast-growing and deep taproot.
- Seedlings are somewhat shade-intolerant.

Treatment Options

- **Pull** or **dig** individual plants by hand in May–June, when plants are bolting or as soon as possible afterwards. (Rosettes often break off from roots, which resprout.) Grasp the plant at the base and pull steadily, straight up. Where several plants grow close together, digging or pulling smaller ones often makes it easy to pull others. Cutting lateral roots and loosening the soil around the base also make it easier to pull. If you cannot pull up the plant, cut it or twist if off at the base.

  Hand pulling is often difficult if plants have stems more than a quarter-inch in diameter. Use a narrow spade, soil knife, or other tool to help free or cut the root. Given that this weed is an annual, most of the taproot can be left in the soil, especially if you manage to get a quarter- to a half-inch of the root below the root crown.

  Continue to recheck and pull emerging plants through August, preferably even later. Hand-pulling can be done in conjunction with mowing: mowing can keep plants from setting seed until you have time to pull.

  Heavy leather gloves are a must! Working with yellow starthistle, the chemicals eventually soak into skin and can be tasted. Although the toxins are not known to harm humans, wash hands after working with this plant.

- **Mow** (or cut with a hand scythe, brushcutter, or any cutting tool) after the plants have bolted and a small fraction of the buds (about 2 percent) have started to bloom. Make sure you mow close enough to the ground to get the lowest buds. Aim to leave 1–2 inches above ground. You may need to mow a second or even a third time at 4–6 week intervals.

  Mowing too early can encourage greater seed production, so it's crucial to time the removal carefully. If there are no buds, it's too early, but if the flowers have mostly bloomed and are losing their bright yellow color, it's too late. Occasionally starthistles bolt sideways with flower heads much closer to the ground, or mowed plants may rebloom very low. You can take the tops off these with a shovel, hoe, or mattock, if in small numbers. Cutting is most effective on dry soil, otherwise a repeat treatment is necessary roughly 4 weeks later.

- **Graze** with cattle, goats, and sheep to help contain plants and reduce seed production. Cattle don't eat mature spiny plants, but goats and sheep are less picky! Best results come from intensive grazing by a large number of animals for a short period of time, preferably from the end of May to June, just after plants have bolted. Research suggests grazing at the rosette stage is counterproductive, leading to an increase in yellow starthistle. This weed is toxic to horses.

- **Foliar spray.** A 1 percent dilution of glyphosate can be sprayed on plants at the bolting stage. You might use this for spot application.

Disposal

Some practitioners advise leaving the clippings from each mowing on-site (as long as they do not contain seeds) to protect the soil from reinfestation by other invasive species, and also to discourage yellow starthistle seedlings by providing extra shade. Plants with only buds and young, pale yellow flowers can be left on the ground. Once flowers turn darker yellow, pulled plants should be bagged, as they may produce viable seed. Dispose of the bags off-site where seeds can't disperse elsewhere. East Bay Regional Park District uses clear plastic bags and leaves the plants in them for a few years.

Follow-Up

A removal program should last at least 3 years and probably longer, though at lower intensity. Watch for new infestations in nearby areas. Mulching may be helpful in shading out seedlings. Some experiments show that a 5-inch layer of wheat straw (or rice straw) stops all regrowth. This level of coverage might be expensive, however, and therefore only an option for small patches.

Interesting Facts

Native to the Mediterranean, yellow starthistle was introduced to the US in the mid-1800s, probably as part of a shipment of contaminated grain or other crop seed. Beekeepers find it to be a valuable source of nectar for honeybees, which account for a large proportion of the thistle's pollination.

Notes

EHRHARTA

Also known as panic veldt grass

Ehrharta erecta

Grass Family (Poaceae)

Description

Ehrharta is a slender, clumping perennial grass found in both disturbed sites and wildlands, particularly in moist, shady areas. It tolerates a variety of soil types.

Ehrharta has semi-erect stems up to 2 feet tall. The leaf blades are broad, green, flat, and 2–5 inches long. The fibrous root system has filaments that sprawl downwards. Fire and drought may spur additional growth. The plant can die back during the dry season, leading to an accumulation of leaf litter.

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Reproduction

Ehrharta reproduces by tiny seeds that are easily dispersed by wind, water, human activity (e.g., gardening equipment or clothing), and possibly birds. Seeds germinate with the start of the winter rains and into late spring. Ehrharta can also spread vegetatively by tillers.

Impact

Ehrharta competes with native grass species, such as Torrey's melic, which has a similar appearance. It can form a continuous carpet of vegetation in moist soil, preventing establishment of other species, particularly annual wildflowers and grasses.

Key Factors

- The same plant can reseed repeatedly throughout the growing season.
- High seed production.
- Seedbank thought to persist for several years.
- Resprouts from stem nodes and tips.

Treatment Options

- **Pull** individual plants and clumps by hand 4–6 times a year, starting at the onset of the rainy season when seedlings first emerge, and continuing until the start of the dry season. (Before pulling, you can flag outlying individuals that could be easily overlooked. Some practitioners have found that as Ehrharta is difficult to see under larger plants, one option is to trim shrubs to expose those grasses growing near the base.) Grasp firmly, making sure you pull below the nodes. If part of the root crown breaks off, dig out the remaining portion.

  If hand removal is your main approach, make sure you get the entire root and all the stems. Hand pulling is feasible in light or patchy infestations, where native species remain. It can be a successful technique if carried out persistently over several years, but may work best in conjunction with other treatments.

- **Cover** dense patches with weed fabric (preferably a permeable barrier to reduce water runoff on slopes) to suppress germination of seedlings.
- **Foliar spray.** Herbicide may be the best option for dense stands of Ehrharta. Given the plant's tendency to grow under other species, make sure you choose a selective herbicide so you don't kill the overlying vegetation.

  Several experimental treatments for mature Ehrharta are underway at Audubon Canyon Ranch in Marin County. These include hand pulling clumps of grasses before the grass starts to flower; covering the infestation with a black polyethylene tarp to solarize the weeds; or applying 1–2 percent glyphosate during senescence (after seeds have set and when the grass is dying back). Initial results suggest glyphosate is effective on mature grasses without prior cutting, although an even weaker concentration may be equally successful. Experimental methods to kill seeds and seedlings include mulching; flaming with a torch; or the use of pre-emergent herbicide. Results are not yet conclusive.

Disposal

Ehrharta seeds germinate readily on contact with water or moist soil, so any seed heads should be bagged immediately and removed from the site.

Follow-Up

Success lies in persistent follow-up, whichever treatment you choose. New seedlings grow very densely and can be tilled with an oscillating hoe. Scrape seedlings off the soil surface and leave them to dry out. If you are covering the Ehrharta, you can cut holes in the tarp and plant native species.

Interesting Facts

Ehrharta is native to South Africa. It became established in California during the 1930s.

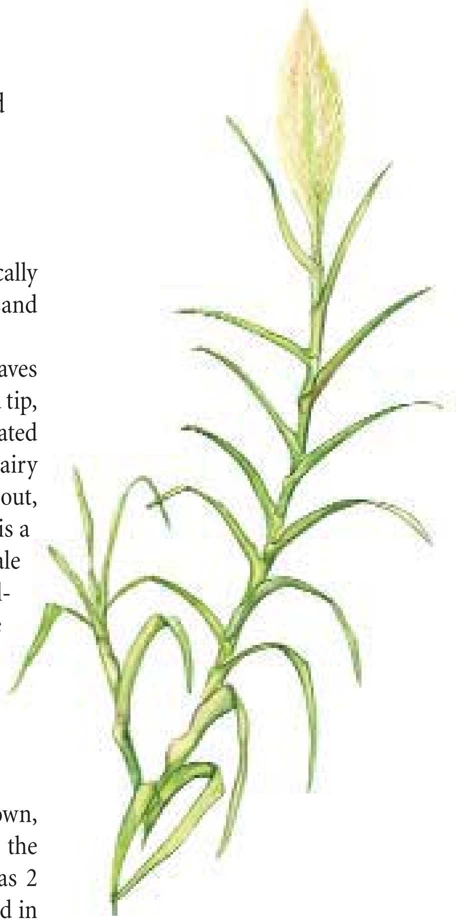
Notes

GIANT REED

Also known as arundo grass, bamboo reed

Arundo donax

Grass Family (Poaceae)



Description

Giant reed is a tall perennial grass that typically forms dense stands on disturbed sites, sand dunes, riparian areas, and wetlands.

Giant reed grows up to 30 feet tall. The leaves are alternate, up to 1 foot long with a tapered tip, slender, and smooth, but with coarsely serrated margins. They are gray-green and have a hairy tuft at the base. The leaves point straight out, droop, or lie folded, and at the base of each is a hairy tuft. As the leaves dry, they turn pale brown like papyrus. The hardy stalks are hollow, about 1 inch in diameter, and resemble bamboo canes. The roots are tough and fibrous and form knotty, spreading mats that penetrate deep into the soil.

Reproduction

The inflorescence is cream to yellowish brown, and appears from March to September in the form of upright, feathery plumes as long as 2 feet. Giant reed does not produce fertile seed in California. Instead, it reproduces vegetatively, by underground rhizomes. Riparian flooding dislodges clumps of giant reed and transports it downstream, where it can root from broken stem nodes and rhizomes. Fire appears to stimulate new growth.

Impact

Giant reed is threatening California's riparian ecosystems by outcompeting native species, such as willows, for water. Its rapid growth and high water uptake allow it to outcompete native vegetation and form monocultural stands. Noxious alkaloids contained in the plant deter wildlife from feeding. Stands of dry leaves and canes are flammable.

Key Factors

- Resprouts from roots and 2-noded stem fragments left in moist soil.
- Roots can reach as deep as 10 feet.
- Rapid growth.

Treatment Options

- Giant reed can be successfully removed only by completely killing the root system, either by thorough physical removal or with herbicide. Pulling and cutting can both be effective techniques if *all* of the rhizomes and aboveground vegetation are removed. Herbicides are often applied as a follow-up to pulling or digging, but the more thoroughly the rhi-

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zomes are removed, the less follow-up herbicide will be needed.

- **Pull** or **dig** plants, from seedlings to 6 feet tall, ideally after heavy rains loosen the soil. It is important to pull up and remove the roots.
- **Cut** the stems of larger plants with a chainsaw or brushcutter, and dig up the roots with a shovel, pickax, or Swedish brush ax. Alternatively, use heavy equipment, such as an excavator.
- **Cut** the stems as close to the ground as possible in May, and cover the clump with a very thick tarp or with several tarps for an entire growing season. This should prevent light from reaching the plant (reducing its ability to photosynthesize), and keep resprouts from tearing the tarp. The lack of light will eventually deplete the plant's energy reserves and it will die back.
- **Foliar spray.** Some practitioners have sprayed a 2–5 percent dilution of glyphosate onto the leaves after the plant has flowered but before summer dormancy.
- **Cut and treat.** As an alternative to foliar spraying, a stronger concentration of glyphosate can be applied to stems immediately after cutting. Make sure that where necessary, you choose an herbicide product suitable for use near water.

Disposal

Both treated and non-treated stems can be left on-site to decompose, although they break down very slowly. If left to compost, the essential point to remember is to keep the debris well away from water. For stems that have not been chemically treated and in areas where it is feasible, the debris can be burned. Otherwise, the canes can be chipped into very small pieces for mulching. The stems are easier to chip when dry, and you will need a heavy-duty chipper to handle the plant's tough fibers. Chipped material can be disposed of either in green waste containers, or spread out to dry and possibly sprayed with herbicide if any regrowth occurs from chipped debris. Stem pieces that have no nodes or only one node won't reproduce.

Interesting Facts

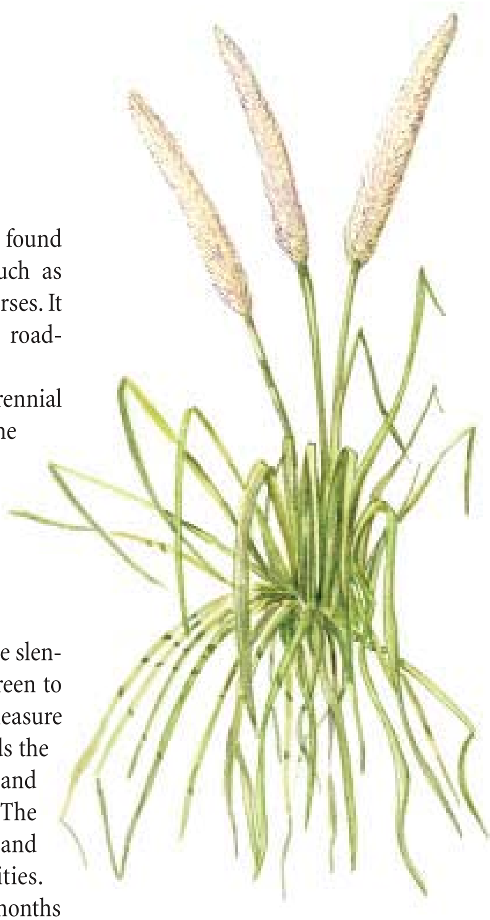
Thought to originate from the Indian subcontinent, giant reed was introduced to California from the Mediterranean in the 1820s for roofing material and erosion control along drainage ditches. It has been cultivated on other continents for thousands of years. Ancient Egyptians wrapped their dead in the leaves. The canes contain silica, perhaps the reason for their durability, and have been used to make fishing rods, walking sticks, and paper. Giant reed is still used to make reeds for woodwind instruments. It continues to be planted for ornamental purposes and erosion control.

Notes

HARDING GRASS

Phalaris aquatica

Grass Family (Poaceae)



Description

Large clumps of Harding grass can be found growing in coastal areas, open sites such as grasslands and rangelands, and watercourses. It also moves into disturbed sites such as roadsides and trails.

Harding grass is an erect, tufted perennial with short rhizomes around the base. The gray-green, hairless leaf blades grow to 15 inches long, and the stems are hollow. Its deep roots allow it to tap into water reserves and withstand drought.

Reproduction

Flowering stems grow up to 4 feet tall. The slender, compact inflorescences turn from green to creamy white in May and June. They measure 2–5 inches long and taper slightly towards the tip. Seed production tends to be high, and occurs between May and September. The seeds are carried short distances by wind and animals and farther by human activities. Seeds can remain dormant for 1–4 months before germinating. Harding grass also spreads vegetatively by sending out tillers or shoots.

Impact

Growth is slow at first, but once established, Harding grass can form dense patches and deprive native species of water and nutrients. During summer drought, the dormant grass increases the risk of fire. Prolonged grazing on Harding grass can cause the potentially fatal staggers disease in sheep.

Key Factors

- Seed longevity is thought to be 1–3 years.
- Removal is easier before large stands are established (the seedlings are less aggressive and do not compete well with other species).
- Resprouts from roots left in the soil.

Treatment Options

- **Cut** around the base of the clump with a Pulaski and dig out the roots. All roots longer than 2 inches must be removed, or the plant could reestablish. Then **mulch** with a thick layer (about 6 inches) of rice straw to discourage resprouts.
- **Mow** close to the ground late in the growing season (generally late spring). Alternatively, mow repeatedly (at least 3 times), ensuring that plants do not flower. Cutting when the grass is at the flowering stage suppresses shoot formation.

PERENNIAL GRASSES

Research points to greater success with repeated mowing, although there's no clear consensus on when during the active growth period this should take place. Multiple mowings weaken the grass and reduce the seedbank, but other methods are needed to prevent new growth; mowing alone will prevent expansion but will not kill Harding grass. However, some land managers believe mowing can actually spread seed; instead, they are disking and reseeding with natives.

- **Brush cut** small patches and **cover** with landscape fabric. Check the fabric monthly to ensure that it is still tightly secured. Alternatively, after brushcutting, **mulch** with a 6-inch layer of rice straw, and pull any emerging plants the following year.
- **Mow and treat.** After mowing the grass close to the ground, some practitioners have experimented with applying 1–2 percent glyphosate using a wick-type applicator after plants have begun to grow back.

Disposal

Bag and dispose of the debris, especially any seed heads, or pile for composting.

Follow-Up

After mowing and covering with landscape fabric, some practitioners have planted native shrubs and trees into the fabric to shade out any Harding grass resprouts that come through.

Interesting Facts

Harding grass is native to Mediterranean Europe. It may have been introduced to the US from Australia for grazing. Its high protein content makes it a valued source of forage for livestock. However, it contains quantities of DMT, a hallucinogen federally classified as a controlled substance. This may explain the sometimes fatal illness it causes in sheep. It has also been used for post-fire revegetation.

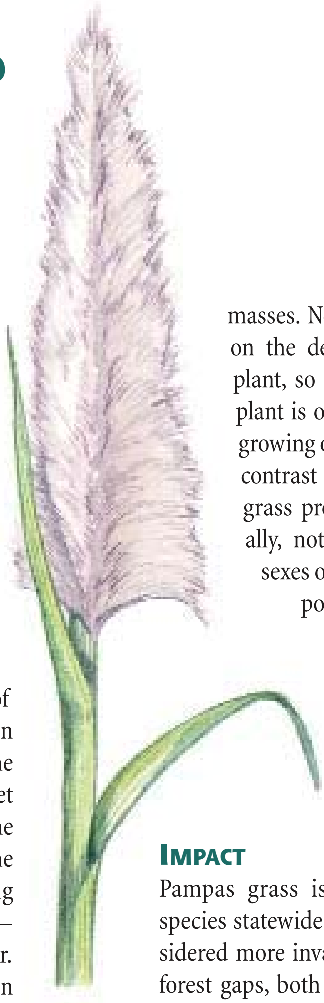
Notes

PAMPAS GRASS AND JUBATA GRASS

Cortaderia selloana

Grass Family (Poaceae)

Cortaderia jubata



Description

Pampas grass is a common name used for both *Cortaderia* species. For clarity in this discussion, *Cortaderia jubata* will be called jubata grass, while pampas grass will refer only to *C. selloana*. Both species are rapid-growing perennials that form large clumps. Jubata grass is found only in coastal areas, but pampas grass also infests more inland locales. Both are found in disturbed areas, slopes and cliffs, coastal scrub, and forest clearings.

Jubata grass leaves reach a height of 5–7 feet at maturity. The dark green leaves have sharply serrated margins. The flowering stalks can tower up to 20 feet above the mass of spreading leaves at the base. The inflorescence—a showy plume ranging from pink to violet, turning creamy white or golden in maturity—typically appears from July to September.

Pampas grass leaves are gray-green and narrower than those of jubata grass. The leaves tend to curl at the tips. The flower stalks grow only a little taller than the mound of leaf blades, giving pampas grass are more rounded appearance than jubata grass. The plumes are paler (generally pale pink to silvery white) than those of jubata grass.

Reproduction

Female jubata grass plants produce seed asexually by apomixis. Thousands of seeds that are genetically identical to the parent plant are then wind-dispersed. Plants live for over a decade, and within their lifetime will develop huge root masses. New seedlings often grow on the dead mass of the parent plant, so what appears to be one plant is often several generations, growing one on top of the other. In contrast to jubata grass, pampas grass produces seeds only sexually, not apomictically, so both sexes of plants are necessary for pollination and seed production. Both grasses can spread vegetatively from tillers or fragments of a mature plant that root in moist soil.

Impact

Pampas grass is the more widespread species statewide, but jubata grass is considered more invasive in coastal areas. In forest gaps, both species can prevent the growth of saplings by limiting available water and nutrients. Both readily establish in disturbed areas including landslides, road cuts, and cliff faces. Seeds are wind-dispersed and populations expand quickly in coastal areas, significantly reducing grassland, scrub, and rocky outcrop habitats. The sharp, sawtooth-edged leaves can cut human skin. Both grasses increase the risk of fire when leaves dry out or die back.

Key Factors

- Serrated leaves require the use of gloves and protective clothing.

- Resprouts from roots left in contact with soil.
- Thrives in moist areas: keep pulled vegetation away from water.
- High seed production.
- Seeds remain viable approximately 9–12 months.

Treatment Options

- **Pull** seedlings by hand or with the help of a pick, Pulaski, or shovel.
- **Cut** larger plants and remove the root mass. First, carefully cut and dispose of all seed plumes, including immature ones that have yet to emerge from their sheath, because they may be able to mature.

  Next, cut stems and leaf blades to near ground level with a Pulaski, Swedish brush ax or chainsaw. Some practitioners prefer to use a chainsaw to remove the mass of leaves, while others caution that this is dangerous (the chainsaw user must kneel and cannot see the blade) as well as slow (the grass quickly clogs the chainsaw guard). An expertly sharpened machete is also effective, but like a chainsaw, is an appropriate tool only for experienced professionals.

  Finally, remove the root mass. If it is very large, use the ax side of the Pulaski to chop it into 4- or 5-inch squares, then use the flat side of the Pulaski to hoe out the pieces.
- **Pull** very large plants with a truck hitch. This is possible if the pampas or jubata grass is near a road and a strong truck is available. Place a choker cable around the plant, digging it into the ground a little behind the plant so it won't slip off. Secure the cable to the truck hitch, and pull the plant out easily. This is very impressive to volunteers!
- **Cut** the plumes of plants you are unable to remove, as a temporary containment measure. Cut the plumes while they are still pink or purple (prior to producing seeds)—typically August to October near the coast, earlier inland and in hotter areas. Note, however, that cut plumes can produce another seed plume from the same stalk in as little as 1–2 weeks.
- **Foliar spray** 2 percent glyphosate on all green growth during the active growth period (November–July, or even August–September along the Central Coast). Spraying minimizes soil disturbance, but the herbicide must contact the entire leaf surface, a difficult task for large plants. An additional caution: plants that appear dead soon after spraying may survive and regrow the following year.
- **Cut and treat.** As an alternative to foliar spraying, you could cut away the stems and leaves and then apply herbicide to the cut stems near the root mass. Practitioners report mixed results with this technique.

Disposal

To prevent resprouting, turn the whole uprooted mass upside down and leave it in place to dry out. Small, stringy roots left in the soil will not regrow, but all parts of the main root mass must be at least several inches away from the ground.

Place the cut plumes on top of cut grass leaves. To prevent any seeds from being blown away, make a "pampas sandwich" by covering the seed heads with a second layer of foliage. Some practitioners bury the seed plumes under something more substantial than the leaves, as they can dry out and blow away—with the seeds! Finding a way to leave the plumes behind means you won't have to haul heavy bags offsite, especially in steep, remote areas. Given that jubata grass seeds don't need to be pollinated, it's important to cover or remove them as soon as possible.

Follow-Up

Check for resprouts twice a year.

Interesting Facts

Pampas grass and jubata grass are native to South America. No one knows quite when and how jubata grass was introduced to California, but pampas grass was introduced to the state in the mid-1800s. Both grasses were widely planted as ornamentals and have been used to prevent erosion on slopes. *Cortaderia* comes from the Spanish for "cutter" and refers to the plant's sharp leaf margins.

Notes

PERENNIAL RYEGRASS

Lolium perenne

Grass Family (Poaceae)

Description

Perennial ryegrass is similar in appearance to annual ryegrass, *Lolium multiflorum*. To distinguish the two grasses: perennial ryegrass lacks awns (short bristles) on its florets; annual ryegrass has awns on its florets. Perennial ryegrass leaves are folded in the bud, but annual ryegrass leaves are rolled in the bud. Perennial ryegrass has more spikelets than annual ryegrass.

Impact

Perennial ryegrass contains alkaloids that appear to become more toxic when under drought stress. In Australia, prolonged grazing of perennial ryegrass can be fatal to sheep and cattle, and cause a form of staggers disease that is different from that caused by other invasive grasses.

Treatment Options

See Harding grass. Brushcutting and covering is especially appropriate for perennial ryegrass as it is a softer grass and thus less likely to push off the landscape fabric.

Notes

PERENNIAL GRASSES

PURPLE VELVET GRASS

Also known as London fog, Yorkshire fog

Holcus lanatus

Grass Family (Poaceae)

Description

Purple velvet grass is a distinctive perennial grass that forms clumps in disturbed areas and, in particular, in moist or mild coastal areas.

The soft, flat, gray-green leaves with velvety hairs grow up to 2 feet tall. The roots are fibrous.

Reproduction

Seed production begins in the plant's second year of growth and tends to be prolific. Dense, purple-tinged inflorescences, reaching up to 3 feet, bloom from May to August. The spikes fade to white once the seeds have ripened, and the grass may go dormant after flowering. The wind-dispersed seeds germinate quickly and seedlings grow rapidly. Purple velvet grass also reproduces vegetatively by producing tillers in late summer.

Impact

Purple velvet grass appears to contain allelopathic compounds that inhibit native plant species. It also has cyanide compounds and may produce an allergic reaction in susceptible people. It dominates an area by forming dense roots that reduce the space available for other species to take up nutrients and water. It also produces significant amounts of thatch.

Key Factors

- Prolific seed production with most seeds germinating rapidly.
- Seeds are not thought to be long-lived.
- Rapid growth.
- Cutting stimulates tillers.

Treatment Options

Except for small, isolated populations, it may be extremely difficult to remove purple velvet grass. Many practitioners have found prescribed burning, brushcutting, and grazing to be ineffective against purple velvet grass.

- **Pull** clumps by hand before seed set, or **cut** them out from around the base with a paring knife. Near Tomales Bay, Audubon Canyon Ranch has had success using these techniques between January and April, prior to when the plant sets seed. The roots are $1\frac{1}{2}$–2 inches on young plants, but can become deep and wide in maturity. Removing seedlings is preferred, because larger roots are more likely to break, especially when soil is dry.
- **Scrape** larger infestations, or chop below the root crown, using the blade end of a McLeod.

Weed whipping the grass first may make scraping easier. Scraping is a control method to discourage seed production, so do it before the grass blooms. Regrowth and new inflorescences will grow close to the ground, so cut the grass as short as you can (1–2 inches off the ground) and be sure to follow up with repeat treatments.

- **Mow** starting in late March before seed set and then repeat monthly until July. Friends of San Bruno Mountain use a high-wheel mower and a string trimmer to crop grasses close to the ground.
- **Cut** small patches of grass back in early spring before bolting and **mulch** with 4–6 inches of rice straw, removing resprouts as they emerge.

Disposal

Bag any hand-pulled grasses and dispose off-site.

Follow-Up

Without constant vigilance, treated areas often become reinfested, so check frequently for seedling growth. Reseed or plant with native perennials: fast-growing bunchgrasses or forbs.

Interesting Facts

This ornamental grass is though to be native to southwest Europe. It was probably introduced to the States either accidentally as a forage contaminant or deliberately as part of a seed mix for meadows. The flowers are used in both dried and fresh flower arrangements. *Lanatus* is Latin for “woolly” and refers to the texture of the leaves.

Notes

PERENNIAL GRASSES

ANNUAL RYEGRASS

Also known as Italian ryegrass

Lolium multiflorum

Grass Family (Poaceae)

Description

Fast-growing but short-lived, annual ryegrass is a cool-season grass found particularly in wetlands, grasslands, and disturbed sites.

Annual ryegrass is an erect grass that grows to 3 feet tall. The flat leaf blades are bright green and glossy, taper gradually to a sharp point, and feel slightly rough at the edges. They measure up to 8 inches long and a quarter-inch wide, and display prominent ridges along the upper surface. Stems often have a reddish tint at the base. A collar is formed where the leaf blade joins the stem. Two sets of roots develop: the first set, deriving from the seed, are short-lived; the second set, which grows closer to the soil surface, comes from tillers. The roots are usually shallow and fibrous, but can grow deep in drier soils. The grass dies back by midsummer, turning dry and yellow.

Reproduction

The inflorescence appears at the top of the stem as a single spike up to 16 inches long made up of alternate, pale yellow spikelets. The seeds are small and have a high rate of germination. Seeds germinate within 10 days—usually with the onset of the rainy season. Seed dormancy develops only in cooler, moist areas. Annual ryegrass also spreads by seed and vegetative shoots or tillers.

Impact

Annual ryegrass reportedly contains allelopathic compounds that inhibit the germination of some species of neighboring plants, while its rapid growth deprives them of water. At the Edgewood Natural Preserve, a serpentine grassland in San Mateo county, annual ryegrass has displaced much of the native dwarf plantain (*Plantago erecta*), the main food source for the native bay checkerspot butterfly. During summer dormancy it accumulates thatch that presents an added fire hazard. It is also a weed in cereal crops, particularly wheat.

Key Factors

- Root system can reach 3 feet or deeper on dry sites.
- Seeds germinate quickly, so there is usually no seedbank build-up.
- Tillers profusely.
- Seedlings are shade-intolerant.
- May be developing resistance to certain herbicides, including glyphosate.

ANNUAL GRASSES

Treatment Options

- **Mow** to about 6 inches using a weed-whacker prior to bolting in the spring. This prevents reinfestation of annual ryegrass by depleting the seedbank, and promotes the survival of native perennial grasses and other species. Timing of mowing varies. At the Tina Baumgartner restoration site in Tilden Park, Berkeley, Shelterbelt mows *repeatedly* (2–3 times) at monthly intervals to remove biomass and developing seeds just as they are beginning to ripen. At the Edgewood Preserve in San Mateo, a *single* mowing is performed in early May before the annual ryegrass seeds ripen but after the annual forbs set seed. Both sites have had considerable success with mowing annual ryegrass (unlike other invasive grasses), with reduction rates at 50–80 percent.
- **Graze** goats on the seed heads. Cattle will also graze on annual ryegrass.

Disposal

Cut grasses can be left on-site to decompose, as long as they have been mowed before they go to seed. Some practitioners rake mowed grasses from an area if they contain viable seed.

Follow-Up

Projects need to be maintained over several years. Research suggests that planting coastal scrub species and native trees may help to control annual ryegrass in chaparral and oak woodland habitat, as the seedlings do not grow well in shade.

Interesting Facts

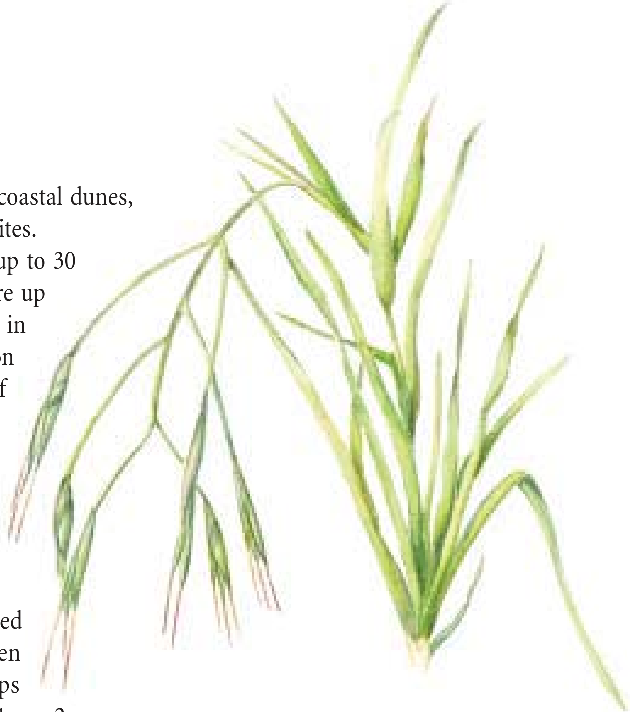
Native to southern Europe, annual ryegrass was introduced to the States for its ability to provide high-quality forage. It is still sown to prolong the grazing season and reduce soil erosion. Research in the South Bay suggests nitrogen deposition from freeway pollution enables annual ryegrass to invade otherwise resistant, naturally nutrient-poor, serpentine soils.

Notes

RIPGUT BROME

Bromus diandrus

Grass Family (Poaceae)



Description

Ripgut brome frequently infests coastal dunes, grasslands, and open, disturbed sites.

The slender stems can grow up to 30 inches tall. The flat leaf blades are up to a quarter-inch wide, covered in fine hairs, and slightly jagged on the margins. The swollen nodes of the stems distinguish ripgut brome from the native purple needlegrass. Ripgut brome has fibrous roots.

Reproduction

Ripgut brome reproduces by seed only. The branched and often drooping inflorescence develops March–June, and consists of 1 or 2 spikelets with stiff, reddish or purple-tipped awns up to 2 inches long. Seed production is high, with a single plant capable of producing up to a thousand seeds. Seeds are usually wind-dispersed and can travel long distances, but they can also become attached to clothing. Germination occurs between November and April. Seeds can persist for up to 5 years.

Impact

Dense stands of dead plant material make this grass very prone to fire during summer drought. In addition, the long, stiff awns are known to cause injury to wildlife. Like many invasive annual grasses, ripgut brome prevents native perennial species from becoming reestablished. For example, research indicates that it outcompetes native oak seedlings for water stored in the soil by means of early germination, sheer volume of numbers, and deep roots.

Key Factors

- High seed production.
- Seed longevity up to 5 years.

Treatment Options

- **Pull** individual plants or small patches by hand in early spring before seeds are ripe. The optimum time for this is when seeds are hanging but while they still contain a milky substance.
- **Mow** or **weed whip** larger infestations. Cut the grass to about 2 inches, making sure you take off the bolting crown. Mowing is usually done from late March to early April before seeds mature.

Follow-Up

Practitioners report considerable success using manual and mechanical methods to eradicate ripgut brome, but sites previously infested by this grass are vulnerable to invasion by species such as annual fescue (*Vulpia bromoides*), a very dominant grass that goes to seed quickly. Therefore follow-up not only includes removing any overlooked seedlings but also checking for new invasive species.

Disposal

Pulled or cut vegetation can be piled on-site as long as the seeds are still immature and produce a milky substance. Alternatively, the grass can be composted.

Interesting Facts

Ripgut brome is native to parts of Europe, including the Mediterranean, and is thought to have become widely established in California as early as the late 1800s. Cattle will eat the grass early in the season when leaves are still tender.

Notes

ACACIA SPECIES

Blackwood acacia *(Acacia melanoxylon)*
Green wattle acacia *(Acacia decurrens)*
Legume or Pea Family (Fabaceae)

Acacia melanoxylon

Description

Blackwood acacia and green wattle acacia are both typically found in disturbed areas and roadsides. Both grow well in moist soils but can tolerate drought.

Blackwood acacia is an evergreen tree that reaches 20–40 feet in height. It has a single trunk with rough, gray bark, and forms a dense pyramidal canopy. Juvenile leaves are finely bipinnately compound, but adult leaves are simple. They are alternate, narrow, straight to sickle-shaped, smooth, and leathery. The leaves measure up to 4 inches long and become a dull, dark green.

Green wattle acacia is a fast-growing small tree or tall shrub that forms dense thickets up to 45 feet tall. The leaves are bipinnately compound, flattened, and dark green.

Impact

Blackwood acacia reportedly has an allelopathic effect, altering soil chemistry and inhibiting germination of native plants. Like many leguminous plants, acacias are nitrogen-fixers, enabling them to establish in nutrient-poor soils. Acacias form dense, monotypic thickets and produce a thick accumulation of leaf litter.

Reproduction

Blackwood acacia reproduces from seed as well as by root suckers and stump sprouting. The roots spread vigorously. Seed production generally begins between 2 and 4 years of age. Clusters of fragrant, pale yellow flowers resembling small pompons appear in January to February. Brown, twisted seed pods, up to 4 inches long, develop in late summer and drop in the fall. Each pod holds 6–10 seeds attached to the pod by pink or red funicles. The seeds themselves are oval, black, and shiny, about a quarter-inch long, and can remain viable for years in the ground. An individual plant can produce 100,000 seeds per year. Seed germination appears to be particularly high following fire.

Key Factors

- High seed production.
- Seeds reported viable for 15–20 years.
- Can sprout from roots and from cut stumps.

Treatment Options

- **Pull** seedlings and small saplings by hand or with a Weed Wrench, preferably when the soil is moist.
- **Cut and treat** with herbicide larger saplings and mature trees.

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- **Cut** to 1 foot **and cover** stump with black plastic or fabric shadecloth.
- **Cut** to 1 foot **and macerate** stump.
- **Girdle or Frill.**
- **Drill and inject** with herbicide.

Disposal
Remove seed pods from the site when feasible. The wood can be cut for firewood.

Follow-Up
Return to the site to check for seedling growth and resprouts at least twice a year. Dig out or cut and treat the resprouts.

Interesting Facts
The genus *Acacia* is one of the largest in the world, comprising around 1,000 species. Blackwood acacia is native to Tasmania, an island south of Australia, where marsupials eat the seedlings. Heights of 130 feet have been recorded, while the oldest tree is 230 years old. It produces lumber of commercial value if grown on suitable sites. In some parts of the world, green wattle acacia is used in cosmetics for skin conditioning, while the bark is used to tan leather. Many *Acacia* species can be highly allergenic.

Notes

BLUE GUM EUCALYPTUS

Eucalyptus globulus

Myrtle Family (Myrtaceae)

Description

Blue gum eucalyptus is found throughout California, particularly in cooler coastal areas. It requires moist soils, access to shallow groundwater, or coastal fog drip.

Blue gum frequently reaches 100 feet or more in height. The smooth, straight trunk can grow to a diameter of 7 feet or more. The pale gray-brown bark peels in long, papery strips to expose a smooth, pale yellow sub-surface. Mature leaves are alternate, lance- or sickle-shaped, and 4–10 inches long. They have a leathery texture and are dull green with a yellow primary vein. In contrast, juvenile leaves are opposite, shorter, and more oval in shape. They are waxy and bluish green, and are nearly sessile (with very short petioles) on sharply squared branches. The bluish green leaves give the blue gum its common name, and the drooping foliage together with the peeling bark and irregular crown give blue gum a distinctive appearance. Blue gum is distinguished from red gum (*Eucalyptus camaldulensis*) by having wider leaves and larger fruits.

Reproduction

Blue gum reproduces both from seed and vegetatively from roots and stumps. Dormant buds produce new shoots from the base of a cut stump. At 4–5 years of age blue gum starts to produce yellowish white flowers, about 2 inches wide, between December and May. These develop into fruits almost a year later. The fruit is a conical, woody capsule roughly 1 inch across. It contains numerous dark brown seeds, which are wind-dispersed and capable of germinating within a few weeks.

Impact

Blue gum can form monospecific stands through superior competition for moisture from the soil and water table and by establishing a dense layer of bark and leaf litter on the ground. Blue gum leaves contain phenolic compounds that are thought to alter soil chemistry and inhibit the germination of native plant species. With their abundant leaf litter, peeling strips of bark, and volatile oils in the leaves, blue gum stands are highly flammable, as was witnessed in the Oakland Hills fire of 1991.

Key Factors

- Vigorously resprouts from cut stumps.
- Seed longevity not known.

Treatment Options

Given its sheer size and persistence, blue gum eucalyptus can be very difficult to control. Removing larger trees is dangerous and often requires a professional arborist. However, blue gum can be temporarily managed by containment until volunteer groups have the resources to remove larger trees and stands. The goal of containment is to keep trees from spreading by removing those on the perimeter of the stands.

- **Pull** small saplings by hand or with a Weed Wrench.
- **Cut and treat.** Cut the stump flat and as low to the ground as possible. Practitioners report using a 25–50 percent dilution of glyphosate. Herbicide must be applied within 5 minutes, and preferably within 1 minute after cutting, while the cambium can still transport the herbicide into the roots. Some people find that the higher the cut is made above the main stem, the greater the chance of resprouts growing below the cut.
- **Cut and cover.** Mature trees up to 8 inches diameter at breast height can typically be cut with a hand saw. Larger trees require a chainsaw. Cover the cut trunk and the surrounding ground 3 feet out from the base of the trunk with landscape fabric and leave for 6–12 months. Check periodically to ensure that the fabric is still tightly secured.
- **Cut and grind or macerate.**

Disposal

Blue gum eucalyptus can be cut for firewood, but when burned it can deposit oily soot in the chimney. Allowing the wood to dry thoroughly makes it easier and cleaner to burn. The wood hardens as it ages, becoming exceptionally difficult to cut, so cutting for firewood should be done within 2 weeks of felling the tree.

Follow-Up

Check for resprouts for at least 3 years or more. Those using herbicide cut any resprouts at the base and treat the cambium a second time, or cut the entire stump and treat again. If a new shoot originates from a point high on the stump, the stump can be cut below it, but if the shoot sprouts from near the ground or from roots, it must be cut and treated directly.

Interesting Facts

Native to Australia and Tasmania, blue gum was introduced to California as an ornamental in the 1850s, and was then widely planted for timber, windbreaks, and fuel. Its timber proved unpopular as it twists in the drying process. Nevertheless, blue gum eucalyptus makes good firewood and paper pulp. Glands on the leaves produce the volatile eucalyptus oil, which can be used as a decongestant. The smell is similar to that of camphor or menthol.

Notes

TREE OF HEAVEN

Ailanthus altissima

Tree of heaven Family (Simaroubaceae)

Description

Tree of heaven is a deciduous tree most commonly found in riparian areas and disturbed inland areas.

Tree of heaven grows 30–65 feet tall, while its trunk can reach 2–3 ft in diameter. It has a broad, dome-shaped crown. The bark is gray and smooth, becoming darker and more scarred with age. The twigs are stout and pale chestnut-brown with rounded buds. The leaves are alternate, pinnately compound, and 1–3 feet long. Each compound leaf comprises 11–25 smaller lance-shaped leaflets, which have 2–4 rounded auricles ("ears") near the base. The leaves have an unpleasant odor when crushed.

Reproduction

Tree of heaven reproduces both from seed and by sprouting vegetatively from stumps and roots. Trees reach reproductive maturity between 10 and 20 years of age. Clusters of small, yellow-green flowers appear in June near the branch tips. Female trees bear winged fruits in September and October. The flat, twisted, papery fruits turn from pink to red-brown with age and hang in large clusters that can last through the winter. Measuring 1–2 inches long, each fruit bears a single seed. A single tree can produce over 300,000 seeds in a year. Seeds are wind-dispersed, but can also spread by water, birds, and machinery. Individual trees live to about 50 years, but new root sprouts often prolong the tree's life span.

Impact

Tree of heaven often forms dense monocultures. The bark and leaves reportedly produce allelopathic chemicals that accumulate in the soil and can cause mortality in other vegetation. The foliage is unpalatable to browsing wildlife.

Key Factors

- Rapid growth and spread from lateral root suckers.
- Persistent resprouts from cut stumps.
- Copious seed production.
- Seeds viable for no more than 1 year.
- Seedlings somewhat shade-intolerant.

Treatment Options

- **Pull** seedlings before a taproot is established (roughly 3 months after germination) while the soil is moist and loose. If a taproot has already formed, **dig** around the base of the plant to completely remove the root system and prevent resprouts. Grubbing out the taproot can be an effective way of killing the plant, but is a slow method best used to control small infestations. Make sure you remove the entire root, as any portion left in the soil can produce a new plant.
- **Cut** stems of mature trees (up to 12 inches in diameter) early in the spring. Cut a second time at the end of the growing season around June or July. This strategy aims to prevent

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seed production with the first cut and to exhaust the plant's energy reserves with the second cut.

- **Cut and treat** trunks or stems with a chainsaw, preferably during the growing season, and before trees have begun to flower. Some practitioners have had success by painting a 50 percent glyphosate solution on the stump immediately after cutting.

Disposal

Slash from trees that have not produced seed can be piled for wildlife cover. Any seeds present are best collected, bagged, and disposed of. If not, you will need to return to the site to pull any seedlings that have germinated.

Follow-Up

You'll need to cut resprouts repeatedly for 3–4 years to eventually kill off the plant's root system. New seedlings and root suckers can be either pulled or cut and treated with herbicide. Establishing a thick shade over tree of heaven seedlings will slow down their growth.

Interesting Facts

Tree of heaven is native to China and was introduced to America in the late 1700s as an ornamental species. It resembles certain trees native to the East Coast, such as sumacs, ash and black walnut. The wood is weak and of little commercial value, although it can be used to produce paper pulp. It has long been used in Chinese medicine for reproductive disorders and to calm spasms. In France, tree of heaven leaves are fed to the Ailanthus moth caterpillar, which yields a silk cheaper and stronger than the fine mulberry silk of China. Invasive in urban areas, tree of heaven was the tree of fame in the book *A Tree Grows in Brooklyn*.

Notes

Resources

There is a wealth of information available to weed workers. The following is but a brief introduction to the organizations and publications that deal with invasive plants.

BAY AREA WEED MANAGEMENT AREAS

Weed Management Areas (WMAs) are county-based groups composed of diverse stakeholders interested in weed control. Their work focuses on three areas: mapping, education, and on-the-ground control projects. Each has an official memorandum of understanding with the state's Department of Food and Agriculture. Most are coordinated by county agricultural departments. WMAs are often the best place to start when looking for local expertise on weed issues.

Alameda/Contra Costa County WMA: (925) 646-5250
Solano County WMA: (707) 421-7465
Marin/Sonoma County WMA: (415) 499-6700
San Francisco County WMA: (415) 668-4392
San Mateo County WMA: (650) 363-4700
Santa Clara County WMA: (408) 224-7476 x822
Santa Cruz County WMA: (831) 763-8080

General Weed Info

tncweeds.ucdavis.edu
A collaboration between UC Davis and the Nature Conservancy, this site includes detailed information on many invasive species, tools, control methods, events, and a listserv.

wric.ucdavis.edu
The Weed Research and Information Center at UC Davis carries out research and disseminates information on weed management to benefit agriculture and natural areas.

www.cal-ipc.org
The California Invasive Plant Council (Cal-IPC) works to protect California wildlands from invasive plants through research, restoration, and education.

www.thewatershedproject.org
The Watershed Project offers outreach programs on creeks, wetlands, and watersheds to the public and educators in the San Francisco Bay Area.

plants.usda.gov
The US Department of Agriculture has a national plant database that includes invasive species.

www.invasivespecies.gov
This site lists invasive species activities and programs at the federal and state level.

www.ice.ucdavis.edu/nrpi
Co-managed by UC Davis and the California Biodiversity Council, the Natural Resource Project Inventory (NRPI) is a database of noxious weed control projects in California.

Species-Specific Info

ceres.ca.gov/tadn
Team Arundo del Norte is a forum of organizations dedicated to controlling *Arundo donax* (giant reed) in Central and Northern California. Its Web site provides comprehensive information on ways to remove giant reed.

www.noivyleague.com
A Web site dedicated to the control of English ivy.

www.ipm.ucdavis.edu
UC Davis' online IPM web site provides detailed information on removing yellow starthistle, invasive blackberries, and other weeds.

Print Publications

www.cdfa.ca.gov
Noxious Times is a quarterly magazine published by the California Department of Food and Agriculture with information on noxious weed control throughout California.

www.cal-ipc.org
Cal-IPC News is published four times a year by the California Invasive Plant Council.

Tools & Equipment

www.lampedesign.com
The Root Talon is designed for pulling up small tree saplings.

www.canonbal.org/weed.html
The Weed Wrench is suitable for pulling up broom.

www.flameeng.com/Vapor_Torch_Kits.html
The Vapor Torch can be used to kill thistles at the rosette stage.

Organizations

In addition to the few organizations listed below, there are many local groups doing weed removal projects.

www.sercal.org
The California chapter of the Society for Ecological Restoration is dedicated to restoring California's damaged ecosystems and offers conferences, workshops, and educational activities.

www.cnps.org
The California Native Plant Society (CNPS) promotes the preservation of California's native flora. Several local chapters in the Bay Area offer events, including weed removal activities: Yerba Buena (for San Francisco and northern San Mateo County), Napa, Marin, East Bay, Santa Clara Valley, and Santa Cruz.

www.acterra.org
Acterra is a Palo Alto-based environmental group that aims to protect and restore the local natural environment through stewardship, information, and leadership. Web site features a calendar of events for the Bay Area.

www.weedcenter.org
The Center for Invasive Plant Management's Web site includes funding opportunities for groups interested in developing a weed management area.

Agencies

www.nps.gov/goga
The Golden Gate National Recreation Area is the largest urban national park in the United States, and offers many education and volunteer opportunities.

www.parks.sfgov.org
The San Francisco Recreation and Park Department has a Natural Areas Program that offers ongoing volunteer opportunities in habitat restoration.

www.ebparks.org
The East Bay Park Regional District works to increase public awareness of the regional parks system. Volunteer opportunities include invasive weed removal.

www.openspace.org
The Midpeninsula Regional Open Space District seeks to acquire and preserve a regional greenbelt of open space land within the Bay Area for future generations. Volunteer opportunities are available.

www.parks.ca.gov
California State Parks aims to preserve the state's biological diversity and protect its natural and cultural resources.

www.cdfa.ca.gov/wma
Weed Management Areas (WMAs) are local organizations that bring together landowners and managers to coordinate efforts against invasive weeds. WMAs exist in most of the Bay Area counties. The Web site lists weed control projects in each WMA.

www.cdpr.ca.gov
The California Department of Pesticide Regulation's Web site features links on integrated pest management, pesticide licensing, pest management grants, and general pesticide information.

Workshops / Trainings

www.merrittlandhort.com
The Department of Landscape Horticulture at Merritt College, Oakland, offers classes in weed identification and control.

www.thewatershedproject.org
The Watershed Project offers workshops based on this handbook.

Glossary

*Terms in **bold print** within definitions are themselves defined in the glossary. Refer also to separate sections on Leaf Terms and Flower Terms at the end of the general section below.*

Achene—a dry, non-fleshy fruit that contains a single seed and does not break open when ripe.

Adventitious roots—roots originating aboveground on a stem and growing into the ground.

Alkaloid—any of a large number of pharmacologically active, potentially toxic, nitrogen compounds produced by plants.

Allelopathic—producing substances (allelochemicals) that are toxic to or inhibit the growth of other plants.

Annual—a plant whose entire life cycle (**germination**, growth, flowering, setting seed, death) occurs within one year (contrast **biennial, perennial**).

Apomixis—production of viable seeds without fertilization having occurred; **asexual** production of seeds.

Asexual—occurring without sexual union, as in **apomixis** or, more commonly, **vegetative reproduction.**

Biennial—a plant that lives two years, flowering and setting seed in the second year (contrast **annual, perennial**).

Biomass—informally, a volume (not mass) of living or dead organic material (for the purposes of this book, all that "stuff" a weed worker must deal with). Technically, *biomass* refers to the weight of all living matter per given unit area. Weight of dead organic material is most properly called *necromass*.

Bolting—rapid elongation of a shoot just before flowering.

Bract—reduced leaf-like structure at the base of a flower or **inflorescence.**

Bulb—fleshy underground shoot that stores carbohydrates and is capable of **vegetative reproduction.**

Bunchgrass—a **perennial** grass that cannot spread vegetatively; all of the buds are located at ground level, at the base of the stems.

Cambium—a layer of living tissue between the xylem (water-conducting tissue) and phloem (food-conducting tissue); in a tree, cambium is found in the current (outermost) year's growth ring. It is the tissue that one severs when girdling a tree.

Chaparral—vegetation type dominated by evergreen shrubs, found beyond the zone of direct coastal influence.

Coastal scrub—vegetation type dominated by shrubs and found at the coast.

Containment—a control strategy short of **eradication** aimed at preventing or limiting the spread of an invasive species.

Eradication—complete elimination of a species, including seeds, from a given area; local extinction.

Foliar—pertaining to leaves (foliage). Foliar application of an herbicide means the herbicide is sprayed on the leaves.

Forb—any herbaceous plant that is not grass-like (i.e., not a grass, rush, or sedge).

Funicle—the stalk of an ovule or seed.

Germination—sprouting of a seed or spore.

Herbaceous—adjective describing non-woody plants, whether **annual, biennial,** or **perennial** (noun form: herb).

Hybridize—to interbreed with different species or sub-species.

Invasive plant—a successfully reproducing species of plant that is, or has the potential to become, unacceptably abundant in a particular plant community. Invasive plants in native ecosystems may alter plant community composition, structure, and function, and diminish habitat value.

Lateral roots—underground roots spreading outward rather than downward (contrast **taproot**).

Monospecific—single-species; e.g. a stand of a single plant species containing no other plant species (or, containing very few other plant species—the term is often used somewhat loosely, rather than strictly literally).

Native plant—a plant species or sub-species that evolved in its present location or dispersed to its present location unaided by humans.

Naturalized plant—a **non-native plant** species that reproduces successfully and is thoroughly established in its introduced range. Plants considered "naturalized" are usually not considered "**invasive**." They may have minimal ecological impact, or be restricted to disturbed habitats such as lawns and roadsides, rather than able to spread into relatively undisturbed habitat.

Nectar—sweet fluid, attractive to pollinators, secreted by many plants in glands at the base of the flower.

Nitrogen-fixing—incorporating nitrogen gas from air into inorganic nitrogen compounds usable by plants; carried out by soil bacteria, especially by bacteria associated with the roots of legumes (Fabaceae, pea-family plants).

Non-native plant—a plant found outside the evolved or historic range of its species; not all non-native plants are **invasive**. *Note:* plants and seeds may be dispersed to new locations over long distances by wind, water, and birds. Such newcomers could be considered non-native unless and until they survive, reproduce, and over generations, co-evolve with their new ecosystem. For the purposes of this book, non-native plants are those introduced by humans, whether deliberately or unintentionally.

Perennial—a plant that lives more than one year (contrast **annual, biennial**).

Phenolic compounds—secondary metabolic compounds produced by plants; these compounds may attract pollinators or seed dispersers, defend against predators, or be poisonous to competitors.

Photosynthesis—the process by which plants produce sugars (photosynthate) from water and carbon dioxide in the presence of chlorophyll using light energy.

Pollination—transfer of pollen from an anther to a stigma (receptive surface of a flower); required for fertilization and **sexual reproduction** in plants.

Rhizome—a horizontal stem growing below the soil surface; may store carbohydrates or function in **vegetative reproduction** (compare **stolon, runner**).

Riparian—pertaining to or growing along watercourses.

Rootball—a non-technical term referring to the major bulk of a compact root system, (e.g., the dense mass of roots of *Cortaderia spp*. excluding the slender roots extending from the main mass).

Root crown—a non-technical term referring to the top portion of the underground root system.

Rosette—growth form characterized by a cluster of leaves radiating from a central point, usually close to the ground at the base of the stem (basal rosette); a common growth form of **biennial** plants in their first year.

Runner—a slender **stolon** that roots at the **nodes** or tip, effecting **vegetative reproduction.**

Seedbank—viable seeds in the soil.

Semi-shrub—a generally **herbaceous, perennial** plant capable of developing woody stems.

Senescence—late life stage of a plant (shortly after reproduction in **annuals**) characterized by loss of vigor and gradual death (from the Latin *senex*, old man).

Sensitive habitat—areas of special concern due to the presence of rare, threatened, or endangered species, or of vulnerable features such as watercourses.

Serpentine—soil derived from weathered serpentinite rock, which is low in the nutrients nitrogen, phosphorous, and calcium, and high in magnesium, nickel, and chromium; also refers to the unusual vegetation found on serpentine soils.

Sexual reproduction—process by which new plants arise from seeds which developed from ovules fertilized by pollen (contrast **vegetative reproduction**).

Shrub—a woody, usually multi-stemmed plant, generally smaller than a tree.

Stolon—a stem that creeps along the ground and produces roots at the **nodes** or tip, giving rise to a new plant through **vegetative reproduction.**

Sucker—a shoot originating from below ground, e.g., from a root.

Taproot—a larger, main root, usually vertical, from which smaller roots branch out; typically found in dicots and not in grasses.

Tiller—an erect shoot originating underground; (verb:) to reproduce vegetatively through tiller production.

Vegetative reproduction—process by which new plants arise without **sexual reproduction** occurring, e.g., from **bulbs, stolons, runners, tillers,** or **suckers.**

Viability—ability of a seed to germinate. *Note:* the length of time a seed remains viable varies widely between species and depends on environmental conditions affecting the seed. Plants producing seeds that remain viable for many years in the soil are said to have high **seedbank** longevity.

LEAF TERMS

Alternate—leaf arrangement in which a single leaf emerges from each **node** on alternating sides of the stem (compare **opposite**).

Bipinnate—twice **pinnate**; the primary pinnae (**leaflets**) are also pinnately **divided.**

Compound leaf—a leaf composed of multiple **leaflets** (compare **simple leaf**).

Divided—cut into distinct parts to the midrib or base.

Elliptic-ovate—leaf shape intermediate between elliptic (the shape of an ellipse, a narrow oval) and ovate (egg-shaped, wider at the stem end).

Lanceolate—lance-shaped leaf: longer than it is wide, with the widest point below the middle of the leaf.

Leaflet—single division of a **compound leaf.**

Lobe—rounded segment of a leaf; a leaf may be deeply lobed and yet not truly **divided.**

Node—a joint of a stem; a place where leaves and branches join a stem.

Opposite—leaf arrangement in which two leaves emerge from each **node** on opposite sides of the stem (compare **alternate**).

Pinnate—leaf arrangement of a **compound leaf** with **leaflets** (pinnae) opposite each other like a feather.

Serrate—saw-like leaf margin; having a sharply toothed leaf margin with teeth pointing forward (compare **toothed**).

Sheathed—partly surrounded by another organ, as a stem partly surrounded by the base of a leaf.

Simple leaf—undivided; not composed of multiple **leaflets** (compare **compound leaf**).

Toothed—leaf margin with teeth pointing outward rather than forward (compare **serrate**).

Triangular-ovate—leaf shape more sharply three-angled than strictly ovate (egg-shaped, wider at the stem end).

FLOWER TERMS

Awn—a slender bristle at the tip or on the dorsal (back) surface.

Floret—a small flower; an individual flower within a cluster (e.g., within a **spikelet** of a grass).

Inflorescence—a cluster of flowers on a plant; a reproductive structure with multiple flowers.

Panicle—an **inflorescence** structured as **racemes** that are themselves branched, extending from a central axis.

Plume—an **inflorescence** that appears feather-like.

Raceme—a branched **inflorescence** arranged with flowers attached individually by pedicels (stalks) to a central axis; lower flowers mature earliest.

Spike—an **inflorescence** arranged with flowers attached individually as in a **raceme**, but without pedicels (unstalked).

Spikelet—a small **spike**; the smallest flower cluster of a grass.

Terminal—at the tip, or terminus.

Umbel—an **inflorescence** structured as a condensed **raceme** with elongated pedicels; the flowers form a flat-topped or convex shape like an umbrella (characteristic of the family Apiaceae).

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Andy Baker, Golden Gate National Parks Conservancy, National Park Service
Peter Brastow, Golden Gate National Recreation Area, National Park Service
Junko Bryant, Urban Creeks Council
Joe Cannon, California Native Plant Society/San Bruno Mountain Stewardship Project
Kim Cooper, Point Reyes National Seashore, National Park Service
Charli Danielsen, Native Here Nursery
Tom Dudley, University of California, Berkeley
Tom Elliott, Golden Gate National Parks Conservancy
Jennifer Erskine, University of California, Davis
Katie Etienne, Audubon Canyon Ranch
Bob Flasher, East Bay Municipal Utility District
Paul Furman, Friends of Edgehill Mountain Park
Karen Gaffney, Circuit Rider Productions
Sue Gardner, Golden Gate National Parks Conservancy
Dan Gluesenkamp, Audubon Canyon Ranch
Ellen Hamingson, Golden Gate National Recreation Area, National Park Service
Mark Heath, Shelterbelt Builders
Lisa Hokholt, US Department of Agriculture, Natural Resources Conservation Service
Matt Horowitz, Natural Resources and Employment Program
Tim Hyland, Santa Cruz District, California State Parks
Marilyn Latta, Save the Bay
Cinda MacKinnon, Environmental Consultant
Ken Moore, Wildlands Restoration Team
Brad Olson, East Bay Regional Park District
An Peischel, Goats Unlimited
Mary Petrilli, California Native Plant Society/San Bruno Mountain Stewardship Project
Mike Pitcairn, California Department of Food & Agriculture
Liz Ponzini, Golden Gate National Parks Conservancy
Brianna Richardson, California Invasive Plant Council and Midpeninsula Regional Open Space District
Susan Schwartz, Friends of Five Creeks
Jake Sigg, California Native Plant Society
Frank Starkey, Catalina Island Conservancy
Katrina Strathmann, Golden Gate National Recreation Area, National Park Service
Joel Trumbo, California Department of Fish & Game
Stuart Weiss, Creekside Center for Earthside Observations
Peter Warner, Mendocino District, California State Parks
Eric Wrubel, Shelterbelt Builders

APPENDIX G

Visual Simulations of Recommended Treatments for Select Areas

Simulation 1 – Existing Condition: North Oakland Regional Sports Field, area above dirt access road within the recommended 30-foot roadside treatment area.

Simulation 1 – Simulated Condition: Area treated to remove all but the dominant tree trunk for multi-trunk trees. Subsequent treatments would be necessary to achieve desired 25-foot spacing between retained trees. Surface vegetation treated to remove ladder fuels and retain some shrubs and non-pyrophytic trees (note retained oak tree in foreground). *Note: eucalyptus stand in background not treated for this simulation, which focuses on 30-foot road buffer area.*

Simulation 2 – Existing Condition: Grizzly Peak Open Space, area along Grizzly Peak Boulevard, looking west.

Simulation 2 – Simulated Condition: Area treated to thin brush density, remove flashy fuels (grasses/weeds) along the roadside, remove some pyrophytic trees, and provide horizontal (ladder fuels) and vertical separation between well-spaced retained trees.

Simulation 3 – Existing Condition: Shepherd Canyon Park, area along the west side of Shepherd Canyon Road, looking west.

Simulation 3 – Simulated Condition: Area treated to remove broom understory, apply surface mulch, prune select lower limbs to remove ladder fuels, and mow weeds along roadside edge. To achieve a desired 35-foot spacing between retained trees, future treatments would be necessary. The depicted interim treatment will allow for retained trees to become more wind-firm before additional thinning occurs.

APPENDIX H

Project Acreages and Estimated Costs

Park/Property	Priority	Project	Vegetation Type	Acreage	Estimated Costs*			
					Cost/Acre - Low	Cost/Acre - High	Cost - Low	Cost - High
Beaconsfield Canyon	**1**	**BCN-1**		**1.67**				
			Closed-cone Pine-Cypress	0.61	$2,560	$7,580	$1,550	$4,589
			Coast Oak Woodland	0.78	$2,560	$4,080	$2,009	$3,202
			Coastal Scrub	0.28	$1,060	$6,580	$296	$1,835
						Total:	***$3,855***	***$9,626***
	2	**BCN-2**		**1.98**				
			Closed-cone Pine-Cypress	0.81	$2,560	$7,580	$2,082	$6,166
			Coastal Scrub	1.17	$1,060	$6,580	$1,241	$7,700
						Total:	***$3,323***	***$13,866***
Blue Rock Court	**1**	**BLU-1**		**2.40**				
			Annual Grassland	0.75	$135	$1,280	$102	$964
			Coast Oak Woodland	0.32	$2,560	$4,080	$822	$1,310
			Eucalyptus	1.28	$2,810	$8,080	$3,609	$10,377
			Urban	0.04	$1,060	$4,080	$39	$148
						Total:	***$4,571***	***$12,800***
	2	**BLU-2**		**0.47**				
			Eucalyptus	0.45	$2,810	$8,080	$1,271	$3,653
			Urban	0.02	$1,060	$4,080	$17	$64
						Total:	***$1,287***	***$3,717***
	3	**BLU-3**		**6.35**				
			Annual Grassland	0.01	$135	$1,280	$1	$8
			Coast Oak Woodland	0.11	$2,560	$4,080	$270	$431
			Eucalyptus	6.24	$2,810	$8,080	$17,542	$50,441
						Total:	***$17,813***	***$50,880***
Dimond Canyon	**1**	**DIM-1**		**3.42**				
			Coast Oak Woodland	2.21	$2,560	$4,080	$5,656	$9,015
			Eucalyptus	0.06	$2,810	$8,080	$177	$509
			Redwood	0.18	$2,560	$4,080	$466	$743
			Urban	0.97	$1,060	$4,080	$1,024	$3,941
						Total:	***$7,323***	***$14,207***
	1	**DIM-2**		**2.47**				
			Coast Oak Woodland	2.18	$2,560	$4,080	$5,591	$8,911
			Coastal Scrub	0.03	$1,060	$6,580	$32	$198
			Urban	0.25	$1,060	$4,080	$267	$1,029
						Total:	***$5,890***	***$10,137***
	1	**DIM-3**		**0.68**				
			Urban	0.68	$1,060	$4,080	$721	$2,774
						Total:	***$721***	***$2,774***
Garber Park	**1**	**GAR-1**		**1.34**				
			Coast Oak Woodland	1.34	$2,560	$4,080	$3,440	$5,482
						Total:	***$3,440***	***$5,482***
	1	**GAR-2**		**0.48**				
			Coast Oak Woodland	0.43	$2,560	$4,080	$1,090	$1,737

Park/Property	Priority	Project	Vegetation Type	Acreage	Estimated Costs*			
					Cost/Acre - Low	Cost/Acre - High	Cost - Low	Cost - High
			Eucalyptus	0.04	$2,810	$8,080	$125	$359
			Freshwater Emergent Wetland	0.01	$0	$0	$0	$0
						Total:	***$1,214***	***$2,096***
	3	**GAR-3**		**0.66**				
			Eucalyptus	0.66	$2,810	$8,080	$1,841	$5,295
						Total:	***$1,841***	***$5,295***
Grizzly Peak Open Space	**1**	**GPO-1**		**28.53**				
			Annual Grassland	0.00	$135	$1,280	$0	$0
			Closed-cone Pine-Cypress	12.29	$2,560	$7,580	$31,460	$93,151
			Coast Oak Woodland	1.62	$2,560	$4,080	$4,154	$6,620
			Coastal Scrub	10.37	$1,060	$6,580	$10,987	$68,205
			Eucalyptus	2.83	$2,810	$8,080	$7,949	$22,856
			Urban	1.43	$1,060	$4,080	$1,513	$5,824
						Total:	***$56,063***	***$196,656***
	2	**GPO-2**		**19.06**				
			Closed-cone Pine-Cypress	8.30	$2,560	$7,580	$21,235	$62,877
			Coastal Scrub	10.43	$1,060	$6,580	$11,052	$68,603
			Eucalyptus	0.34	$2,810	$8,080	$942	$2,707
						Total:	***$33,229***	***$134,188***
	3	**GPO-3**		**1.62**				
			Coast Oak Woodland	1.62	$2,560	$4,080	$4,152	$6,618
							$0	$0
						Total:	***$4,152***	***$6,618***
	3	**GPO-4**		**19.90**				
			Closed-cone Pine-Cypress	7.01	$1,060	$1,280	$7,433	$8,976
			Coastal Scrub	12.46	$1,060	$1,280	$13,211	$15,952
			Eucalyptus	0.22	$1,060	$1,280	$232	$280
			Urban	0.21	$1,060	$1,280	$222	$268
						Total:	***$13,664***	***$16,500***
Joaquin Miller Park	**1**	**JMP-1**		**117.32**				
			Annual Grassland	6.06	$135	$1,280	$818	$7,755
			Closed-cone Pine-Cypress	56.37	$2,560	$7,580	$144,314	$427,304
			Coast Oak Woodland	15.62	$2,560	$4,080	$39,995	$63,742
			Coastal Scrub	0.72	$1,060	$6,580	$768	$4,764
			Eucalyptus	17.73	$2,810	$8,080	$49,827	$143,273
			Freshwater Emergent Wetland	0.10	$0	$0	$0	$0
			Redwood	9.52	$2,560	$4,080	$24,363	$38,828
			Urban	9.20	$1,060	$4,080	$9,752	$37,535
			Urban (acacia)	0.94	$2,810	$8,080	$2,638	$7,584
			Urban (mixed)	0.83	$1,060	$4,080	$877	$3,376
			Valley/foothill Riparian	0.22	$0	$0	$0	$0
						Total:	***$273,350***	***$734,162***
	1	**JMP-2**		**18.23**				
			Annual Grassland	0.36	$135	$1,280	$49	$462

Park/Property	Priority	Project	Vegetation Type	Acreage	Estimated Costs*			
					Cost/Acre - Low	Cost/Acre - High	Cost - Low	Cost - High
			Closed-cone Pine-Cypress	6.14	$2,560	$7,580	$15,710	$46,516
			Coast Oak Woodland	2.60	$2,560	$4,080	$6,664	$10,621
			Eucalyptus	2.68	$2,810	$8,080	$7,527	$21,642
			Redwood	4.05	$2,560	$4,080	$10,375	$16,536
			Urban	2.06	$1,060	$4,080	$2,186	$8,413
			Urban (mixed)	0.34	$1,060	$4,080	$356	$1,369
						Total:	***$42,866***	***$105,560***
	2	**JMP-3**		**13.82**				
			Annual Grassland	0.12	$135	$1,280	$16	$153
			Closed-cone Pine-Cypress	3.52	$2,560	$7,580	$9,023	$26,718
			Coast Oak Woodland	1.05	$2,560	$4,080	$2,698	$4,301
			Coastal Scrub	1.95	$1,060	$6,580	$2,067	$12,829
			Eucalyptus	2.88	$2,810	$8,080	$8,105	$23,306
			Redwood	0.01	$2,560	$4,080	$18	$29
			Urban	0.03	$1,060	$4,080	$31	$119
			Urban (acacia)	2.25	$2,810	$8,080	$6,329	$18,199
			Urban (mixed)	2.00	$1,060	$4,080	$2,120	$8,161
						Total:	***$30,408***	***$93,814***
	3	**JMP-4**		**68.31**				
			Annual Grassland	8.53	$1,060	$1,280	$9,038	$10,914
			Closed-cone Pine-Cypress	13.81	$1,060	$1,280	$14,639	$17,677
			Coast Oak Woodland	14.11	$1,060	$1,280	$14,952	$18,055
			Coastal Scrub	0.62	$1,060	$1,280	$654	$790
			Eucalyptus	6.33	$1,060	$1,280	$6,714	$8,108
			Redwood	5.62	$1,060	$1,280	$5,957	$7,193
			Urban	17.06	$1,060	$1,280	$18,087	$21,841
			Urban (acacia)	1.73	$1,060	$1,280	$1,838	$2,219
			Urban (mixed)	0.50	$1,060	$1,280	$527	$636
						Total:	***$72,406***	***$87,434***
King Estate	**1**	**KES-1**		**15.57**				
			Annual Grassland	8.99	$135	$1,280	$1,214	$11,506
			Coast Oak Woodland	3.81	$2,560	$4,080	$9,741	$15,525
			Coastal Scrub	0.04	$1,060	$6,580	$43	$264
			Urban	2.73	$1,060	$4,080	$2,898	$11,153
						Total:	***$13,895***	***$38,448***
	3	**KES-2**		**65.63**				
			Annual Grassland	52.07	$1,060	$1,280	$55,194	$66,650
			Coast Oak Woodland	8.19	$1,060	$1,280	$8,682	$10,484
			Coastal Scrub	4.23	$1,060	$1,280	$4,479	$5,408
			Urban	1.14	$1,060	$1,280	$1,212	$1,463
						Total:	***$69,567***	***$84,006***
Knowland Park and Arboretum	**1**	**KNO-1**		**28.43**				
			Annual Grassland	10.16	$135	$1,280	$1,372	$13,007
			Closed-cone Pine-Cypress	1.43	$2,560	$7,580	$3,669	$10,865

Park/Property	Priority	Project	Vegetation Type	Acreage	Estimated Costs*			
					Cost/Acre - Low	Cost/Acre - High	Cost - Low	Cost - High
			Coast Oak Woodland	5.66	$2,560	$4,080	$14,495	$23,101
			Coastal Scrub	3.16	$1,060	$6,580	$3,354	$20,819
			Eucalyptus	2.71	$2,810	$8,080	$7,616	$21,900
			Perennial Grassland	0.02	$135	$1,280	$3	$29
			Urban	5.28	$1,060	$4,080	$5,597	$21,544
						Total:	***$36,106***	***$111,265***
	1	**KNO-2**		**8.39**				
			Annual Grassland	0.64	$135	$1,280	$86	$818
			Coast Oak Woodland	6.12	$2,560	$4,080	$15,656	$24,952
			Coastal Scrub	0.49	$1,060	$6,580	$522	$3,240
			Eucalyptus	0.56	$2,810	$8,080	$1,587	$4,563
			Urban	0.58	$1,060	$4,080	$611	$2,352
						Total:	***$18,463***	***$35,926***
	2	**KNO-3**		**14.01**				
			Annual Grassland	0.10	$135	$1,280	$13	$127
			Closed-cone Pine-Cypress	0.02	$2,560	$7,580	$49	$145
			Coast Oak Woodland	3.22	$2,560	$4,080	$8,243	$13,137
			Coastal Scrub	10.65	$1,060	$6,580	$11,290	$70,083
			Eucalyptus	0.00	$2,810	$8,080	$12	$33
			Perennial Grassland	0.00	$135	$1,280	$0	$2
			Urban	0.02	$1,060	$4,080	$19	$72
						Total:	***$19,626***	***$83,600***
	2	**KNO-4**		**32.10**				
			Annual Grassland	2.29	$135	$1,280	$309	$2,931
			Coast Oak Woodland	2.11	$2,560	$4,080	$5,412	$8,625
			Eucalyptus	0.26	$2,810	$8,080	$719	$2,068
			Urban	27.44	$1,060	$4,080	$29,090	$111,967
						Total:	***$35,530***	***$125,592***
	3	**KNO-5**		**368.13**				
			Annual Grassland	87.92	$1,060	$1,280	$93,199	$112,542
			Closed-cone Pine-Cypress	7.61	$1,060	$1,280	$8,063	$9,737
			Coast Oak Woodland	144.34	$1,060	$1,280	$152,999	$184,754
			Coastal Scrub	47.45	$1,060	$1,280	$50,302	$60,742
			Eucalyptus	8.54	$1,060	$1,280	$9,054	$10,933
			Freshwater Emergent Wetland	0.17	$1,060	$1,280	$181	$219
			Mixed Chaparral	7.92	$1,060	$1,280	$8,400	$10,144
			Perennial Grassland	12.51	$1,060	$1,280	$13,258	$16,009
			Redwood	0.18	$1,060	$1,280	$186	$224
			Urban	51.48	$1,060	$1,280	$54,574	$65,901
						Total:	***$390,216***	***$471,204***
Leona Heights Park	**1**	**LHT-1**		**13.57**				
			Annual Grassland	0.28	$135	$1,280	$38	$356
			Coast Oak Woodland	7.07	$2,560	$4,080	$18,111	$28,865
			Eucalyptus	2.08	$2,810	$8,080	$5,831	$16,767
			Redwood	3.74	$2,560	$4,080	$9,569	$15,251

Park/Property	Priority	Project	Vegetation Type	Acreage	Estimated Costs*			
					Cost/Acre - Low	Cost/Acre - High	Cost - Low	Cost - High
			Urban	0.41	$1,060	$4,080	$430	$1,657
						Total:	***$33,979***	***$62,895***
	1	**LHT-2**		**1.86**				
			Coast Oak Woodland	1.14	$2,560	$4,080	$2,917	$4,650
			Redwood	0.39	$2,560	$4,080	$1,000	$1,594
			Urban	0.33	$1,060	$4,080	$346	$1,332
						Total:	***$4,263***	***$7,575***
	2	**LHT-3**		**3.78**				
			Coast Oak Woodland	3.49	$2,560	$4,080	$8,941	$14,249
			Redwood	0.29	$2,560	$4,080	$748	$1,193
						Total:	***$9,689***	***$15,442***
Leona Street	**1**	**LST-1**		**0.38**				
			Coast Oak Woodland	0.16	$2,560	$4,080	$415	$662
			Eucalyptus	0.22	$2,810	$8,080	$611	$1,758
						Total:	***$1,027***	***$2,420***
McDonell Avenue	**1**	**MCD-1**		**0.95**				
			Coast Oak Woodland	0.55	$2,560	$4,080	$1,397	$2,226
			Urban	0.40	$1,060	$4,080	$425	$1,636
						Total:	***$1,822***	***$3,862***
Medians	**1**	**MEDIAN**		**5.66**				
			Annual Grassland	0.93	$135	$1,280	$126	$1,190
			Closed-cone Pine-Cypress	0.53	$2,560	$7,580	$1,344	$3,980
			Coast Oak Woodland	1.22	$2,560	$4,080	$3,114	$4,963
			Eucalyptus	0.02	$2,810	$8,080	$51	$146
			Urban	2.97	$1,060	$4,080	$3,145	$12,107
						Total:	***$7,780***	***$22,386***
Marjorie Saunders Park	**1**	**MJS-1**		**0.87**				
			Closed-cone Pine-Cypress	0.04	$2,560	$7,580	$113	$335
			Coast Oak Woodland	0.10	$2,560	$4,080	$264	$421
			Eucalyptus	0.72	$2,810	$8,080	$2,033	$5,845
						Total:	***$2,410***	***$6,602***
	2	**MJS-2**		**1.81**				
			Closed-cone Pine-Cypress	0.15	$2,560	$7,580	$380	$1,124
			Eucalyptus	1.66	$2,810	$8,080	$4,660	$13,398
						Total:	***$5,039***	***$14,523***
North Oakland Regional Sports Field	**1**	**NOR-1**		**21.51**				
			Coast Oak Woodland	5.11	$2,560	$4,080	$13,079	$20,845
			Coastal Scrub	0.47	$1,060	$6,580	$495	$3,075
			Eucalyptus	12.06	$2,810	$8,080	$33,891	$97,453
			Urban	3.87	$1,060	$4,080	$4,100	$15,782
						Total:	***$51,566***	***$137,155***

Park/Property	Priority	Project	Vegetation Type	Acreage	Estimated Costs*			
					Cost/Acre - Low	Cost/Acre - High	Cost - Low	Cost - High
	2	**NOR-2**		**7.76**				
			Eucalyptus	7.76	$2,810	$8,080	$21,819	$62,739
						Total:	***$21,819***	***$62,739***
	3	**NOR-3**		**18.65**				
			Coast Oak Woodland	16.87	$2,560	$4,080	$43,183	$68,823
			Coastal Scrub	1.62	$1,060	$6,580	$1,714	$10,641
			Urban	0.16	$1,060	$4,080	$172	$660
						Total:	***$45,069***	***$80,125***
Oak Knoll	**1**	**OKN-1**		**1.23**				
			Annual Grassland	0.18	$135	$1,280	$24	$225
			Coast Oak Woodland	0.28	$2,560	$4,080	$707	$1,126
			Urban	0.77	$1,060	$4,080	$821	$3,159
						Total:	***$1,551***	***$4,510***
	3	**OKN-2**		**14.51**				
			Annual Grassland	2.75	$1,060	$1,280	$2,919	$3,525
			Coast Oak Woodland	0.15	$1,060	$1,280	$155	$188
			Eucalyptus	1.28	$1,060	$1,280	$1,358	$1,640
			Urban	10.33	$1,060	$1,280	$10,952	$13,225
						Total:	***$15,385***	***$18,578***
Police/Safety Department Property	**1**	**PSD-1**		**7.17**				
			Eucalyptus	4.27	$2,810	$8,080	$12,001	$34,509
			Urban	2.90	$1,060	$4,080	$3,076	$11,840
						Total:	***$15,077***	***$46,348***
	1	**PSD-2**		**0.54**				
			Eucalyptus	0.54	$2,810	$8,080	$1,524	$4,382
						Total:	***$1,524***	***$4,382***
Sheffield Village Open Space	**1**	**SHF-1**		**23.92**				
			Annual Grassland	1.60	$135	$1,280	$216	$2,051
			Closed-cone Pine-Cypress	0.15	$2,560	$7,580	$388	$1,149
			Coast Oak Woodland	5.17	$2,560	$4,080	$13,226	$21,079
			Coastal Scrub	1.20	$1,060	$6,580	$1,267	$7,864
			Eucalyptus	3.32	$2,810	$8,080	$9,332	$26,834
			Perennial Grassland	0.04	$135	$1,280	$5	$46
			Urban	12.45	$1,060	$4,080	$13,195	$50,789
						Total:	***$37,629***	***$109,812***
	2	**SHF-2**		**6.14**				
			Annual Grassland	0.02	$135	$1,280	$3	$29
			Coast Oak Woodland	1.83	$2,560	$4,080	$4,693	$7,479
			Coastal Scrub	3.70	$1,060	$6,580	$3,919	$24,327
			Eucalyptus	0.08	$2,810	$8,080	$220	$632
			Urban	0.51	$1,060	$4,080	$543	$2,091
						Total:	***$9,378***	***$34,558***
	3	**SHF-3**		**288.34**				

Park/Property	Priority	Project	Vegetation Type	Acreage	Estimated Costs*			
					Cost/Acre - Low	Cost/Acre - High	Cost - Low	Cost - High
			Annual Grassland	57.04	$1,060	$1,280	$60,457	$73,005
			Closed-cone Pine-Cypress	5.74	$1,060	$1,280	$6,080	$7,342
			Coast Oak Woodland	129.35	$1,060	$1,280	$137,112	$165,570
			Coastal Scrub	53.85	$1,060	$1,280	$57,078	$68,925
			Eucalyptus	21.80	$1,060	$1,280	$23,109	$27,905
			Perennial Grassland	0.81	$1,060	$1,280	$855	$1,033
			Urban	19.76	$1,060	$1,280	$20,950	$25,299
						Total:	***$305,642***	***$369,077***
Shepherd Canyon Park	**1**	**SHP-1**		**13.23**				
			Closed-cone Pine-Cypress	0.37	$2,560	$7,580	$952	$2,818
			Coast Oak Woodland	6.00	$2,560	$4,080	$15,360	$24,480
			Eucalyptus	5.93	$2,810	$8,080	$16,664	$47,915
			Urban	0.93	$1,060	$4,080	$981	$3,775
						Total:	***$33,956***	***$78,988***
	1	**SHP-2**		**9.26**				
			Closed-cone Pine-Cypress	0.24	$2,560	$7,580	$604	$1,787
			Coast Oak Woodland	6.58	$2,560	$4,080	$16,851	$26,857
			Eucalyptus	2.39	$2,810	$8,080	$6,725	$19,338
			Urban	0.05	$1,060	$4,080	$52	$199
						Total:	***$24,232***	***$48,181***
	2	**SHP-3**		**11.78**				
			Annual Grassland	0.21	$135	$1,280	$28	$269
			Coast Oak Woodland	2.79	$2,560	$4,080	$7,138	$11,375
			Eucalyptus	7.31	$2,810	$8,080	$20,527	$59,025
			Urban	1.48	$1,060	$4,080	$1,565	$6,024
						Total:	***$29,258***	***$76,693***
	3	**SHP-4**		**20.37**				
			Annual Grassland	1.79	$1,060	$1,280	$1,901	$2,296
			Closed-cone Pine-Cypress	0.88	$1,060	$1,280	$931	$1,125
			Coast Oak Woodland	16.16	$1,060	$1,280	$17,130	$20,685
			Eucalyptus	0.98	$1,060	$1,280	$1,038	$1,253
			Urban	0.56	$1,060	$1,280	$597	$721
						Total:	***$21,597***	***$26,080***
Tunnel Road Open Space	**1**	**TRO-1**		**4.44**				
			Annual Grassland	1.25	$1,060	$1,280	$1,320	$1,594
			Coast Oak Woodland	2.73	$1,060	$1,280	$2,892	$3,492
			Urban	0.47	$1,060	$1,280	$495	$598
						Total:	***$4,707***	***$5,684***
Urban and Residential Parcels	**1**	**URB-1**		**47.47**				
			Annual Grassland	2.41	$135	$1,280	$325	$3,080
			Closed-cone Pine-Cypress	8.85	$2,560	$7,580	$22,662	$67,099
			Coast Oak Woodland	16.32	$2,560	$4,080	$41,789	$66,602
			Coastal Scrub	2.40	$1,060	$6,580	$2,542	$15,780

Park/Property	Priority	Project	Vegetation Type	Acreage	Estimated Costs*			
					Cost/Acre - Low	Cost/Acre - High	Cost - Low	Cost - High
			Eucalyptus	10.72	$2,810	$8,080	$30,113	$86,587
			Redwood	0.23	$2,560	$4,080	$588	$937
			Urban	6.30	$1,060	$4,080	$6,675	$25,692
			Urban (acacia)	0.24	$2,810	$8,080	$679	$1,953
						Total:	***$105,373***	***$267,731***
						Grand Total:	***$1,949,872***	

Totals:

Priority	Acreage			Total Cost (Low)	Total Cost (High)
1	**380.97**			**$757,826**	**$1,973,630**
2	**112.72**			**$198,585**	**$658,732**
3	**872.48**			**$957,354**	**$1,215,797**
Grand Total:	**1,366.17**			***$1,913,765***	***$3,848,159***

** Notes:*
All costs per acre include biological monitoring
Costs for Eucalyptus and Urban (acacia) vegetation types also include herbicide application

APPENDIX I

Best Management Practices for General Operations, Vegetation Management, and Protection of Biological Resources

APPENDIX I
Best Management Practices for General Operations, Vegetation Management, and Protection of Biological Resources

BMP Number	BMP Title	BMP Description
General Management Practices		
GEN-1	Work Windows	▪ Hand pruning and hand removal of vegetation may occur year round, except when wheeled or tracked equipment needs to access a site by crossing a creek, ponded area, or secondary channel. ▪ Herbicide applications (if selected as a vegetation management technique) will occur between June 15 and November 15, with an extension through December 31 or until the first occurrence of local rainfall greater than 0.5 inch is forecasted within a 24-hour period following planned application events.
GEN-2	Minimize Area of Disturbance	To minimize impacts to natural resources, the area of ground disturbance will be limited to the minimum footprint necessary to meet the goals and objectives of the vegetation management activity.
GEN-3	Erosion and Sediment Control Measures	▪ Upland soils exposed by maintenance activities will be seeded and stabilized using erosion control fabric or hydroseeding. Channel beds and areas below the ordinary high water mark (OHWM) are exempt from this BMP. ▪ Erosion control fabrics will consist of natural fibers that biodegrade over time. No plastic or other non-porous material will be used as part of a permanent erosion control approach. Plastic sheeting may be used to protect a slope from runoff temporarily, but only if there are no indications that special-status species would be affected by the application. ▪ Erosion control measures will be installed according to manufacturer's specifications. ▪ Appropriate measures include, but are not limited to, the following: – silt fences – straw bale barriers – brush or rock filters – storm drain inlet protection – sediment traps – sediment basins – erosion control blankets and mats – soil stabilization (e.g., tackified straw with seed, jute, or geotextile blankets, broadcast and hydroseeding) ▪ All temporary construction-related erosion control methods (e.g., silt fences) shall be removed at the completion of the project.

APPENDIX I
Best Management Practices for General Operations, Vegetation Management, and Protection of Biological Resources

BMP Number	BMP Title	BMP Description
		The following California Stormwater Quality Association (CASQA) Construction BMPs provide guidance and specifications on implementation of the erosion control measures listed above (see also www.casqa.org/resources/bmp-handbooks/construction): – SC-3. Sediment Basins – SC-4. Straw or Sand Bag Barriers – SC-5. Sediment Traps – SC-6. Silt Fences – SS-1. Erosion Control Blankets, Mats, and Geotextiles – VR-1. Brush or Rock Filters – VR-4a. Temporary Outlet Protection – VR-4b. Storm Drain Inlet Protection – WD-1. Earth Dike – WD-1. Slope Drain – WD-3. Temporary Drains and Swales
GEN-4	Staging	▪ To the extent feasible, staging will occur on access roads, surface streets, or other disturbed areas that are already compacted and support only ruderal vegetation. Similarly, all vegetation management equipment and materials (e.g., road rock and project spoils) will be contained within the existing service roads, paved roads, or other pre-determined staging areas. Staging areas for equipment, personnel, vehicle parking, and material storage will be sited as far as possible from major roadways.
GEN-5	On-Site Hazardous Materials Management	▪ An inventory of all hazardous materials used (and/or expected to be used) at the work site and the end products that are produced (and/or expected to be produced) after their use will be maintained by the worksite manager. ▪ As appropriate, containers will be properly labeled with a "Hazardous Waste" label and hazardous waste will be recycled or disposed of properly off-site at an appropriate hazardous waste facility. ▪ Contact of chemicals with precipitation will be minimized by storing chemicals in watertight containers or in a storage shed (completely enclosed), with appropriate secondary containment to prevent any spillage or leakage.

APPENDIX I
Best Management Practices for General Operations, Vegetation Management, and Protection of Biological Resources

BMP Number	BMP Title	BMP Description
		▪ Petroleum products, chemicals, cement, fuels, lubricants, non-storm-drainage water, and water contaminated with the aforementioned materials will not contact soil and will not be allowed to enter surface waters or the storm drainage system. ▪ All toxic materials, including waste disposal containers, will be covered when not in use and located as far as possible from any direct connection to the storm drainage system or surface water. ▪ All trash that is brought to a project site during maintenance activities (e.g., plastic water bottles, lunch bags, cigarettes) will be removed from the site daily.
GEN-6	Existing Hazardous Materials	▪ If previously unknown hazardous contaminants, including oil, batteries, or paint cans, are encountered during vegetation management work, City personnel will cease activity and will contact the Alameda County Public Health Department to determine what measures need to be implemented to address the hazardous materials and ensure that the work site is safe for people and the environment. As directed by the Alameda County Public Health Department, City personnel will carefully remove and dispose of hazardous materials. ▪ City personnel will wear proper protective gear when handling hazardous materials. All contaminated materials will be stored in appropriate hazardous waste containers for transport and disposal at a permitted hazardous waste facility.
GEN-7	Spill Prevention and Response	▪ City personnel will prevent the accidental release of chemicals, fuels, lubricants, and non-storm-drainage water into channels by following these measures: 1. New City field personnel will be trained appropriately in spill prevention, hazardous material control, and cleanup of accidental spills. 2. Equipment and materials for cleanup of spills will be available on site at all times, and spills and leaks will be cleaned up immediately and disposed of at a hazardous waste facility. 3. City field personnel will ensure that hazardous materials are handled properly and natural resources are protected by all reasonable means. 4. Spill prevention kits will always be in close proximity when City personnel are using hazardous materials (e.g., at crew trucks and other reasonable locations). All City field personnel will be advised of these locations. 5. City personnel will routinely inspect the work site, vehicles, and equipment to verify that spill prevention and response measures are implemented and maintained properly. All leaks will be repaired promptly. Drip pans will be used to catch leaks until repairs are made. ▪ For small spills on impervious surfaces, absorbent materials will be used to remove the spill, rather than hosing it down with water. For small spills on pervious surfaces such as soil, the spill area will be excavated

BMP Number	BMP Title	BMP Description
		and properly disposed of rather than being buried. Absorbent materials will be collected and disposed of properly and promptly. ▪ All significant spills of hazardous materials, including oil, will be reported immediately. To report a spill: 1) Dial 911 or your local emergency response number; and 2) Call the Governor's Office of Emergency Services Warning Center, (800) 852-7550 (24 hours).
GEN-8	Vehicle and Equipment Maintenance	▪ All vehicles and equipment will be kept clean. Excessive buildup of oil and grease will be prevented. ▪ Incoming vehicles and equipment (including delivery trucks and employee and subcontractor vehicles) will be checked for leaking oil and fluids. Leaking vehicles or equipment will not be allowed on-site. ▪ No heavy equipment will operate in a live stream. ▪ No equipment will be serviced in the creek channel or immediate floodplain, unless equipment stationed in these locations cannot be readily relocated (i.e., pumps and generators). ▪ If necessary, servicing of equipment at the job site will be conducted in a designated, protected area to reduce threats to water quality from vehicle fluid spills. Designated service areas will not connect directly to the ground, surface water, or storm drain system. The service area will be clearly designated with berms, sand bags, or other barriers. Secondary containment, such as a drain pan, will be used to catch spills or leaks when removing or changing fluids. Fluids will be stored in appropriate containers with covers, and recycled or disposed of properly off-site. ▪ If emergency repairs are required in the field, only those repairs necessary to move equipment to a more secure location will be conducted in the channel or floodplain. ▪ Equipment will be cleaned of any sediment or vegetation before being transferred and used in a different watershed, to avoid spreading sediment, pathogens, or exotic/invasive species. ▪ Vehicle and equipment washing can take place on-site only as needed to prevent the spread of sediment, pathogens, or exotic/invasive species. No runoff from vehicle or equipment washing will be allowed to enter water bodies, including creek channels and storm drains, without being subjected to adequate filtration (e.g., vegetated buffers, hay wattles or bales, and silt screens). The discharge of decant water from any on-site wash area to water bodies or areas outside of the active project site is prohibited.
GEN-9	Vehicle and Equipment Fueling	▪ No fueling will be done stream channels (top-of-bank to top-of-bank) or immediate floodplain. ▪ All off-site fueling sites (i.e., on access roads above the top-of-bank) will be equipped with secondary containment and avoid a direct connection to soil, surface water, or the storm drainage system.

BMP Number	BMP Title	BMP Description
		▪ For stationary equipment that must be fueled on-site, secondary containment, such as a drain pan or drop cloth, will be used to prevent accidental spills of fuels from reaching soil, surface water, or the storm drain system.
Vegetation Management		
VEG-1	Routine Pruning Measures	1. Pruning will be performed according to the most recently published National ANSI A300 Pruning Standards and ISA BMPs for Tree Pruning, which include guidance on pruning practices, pruning objectives, pruning methods (types), palm pruning, and utility pruning. 2. Pruning activities will follow National ANSI Z133.1-2006 Standards for safe operation of tree care machinery, and safety equipment such as carabiners, helmets, and arborist ropes will be used to ensure the safety of tree climbers.
VEG-2	Standard Herbicide Use Requirements	▪ Hand or mechanical vegetation removal will be used in areas within 0.25 mile of schools. Herbicides (if selected as a vegetation management technique) will be applied only if hand or mechanical vegetation removal is not feasible. ▪ Only herbicides and surfactants that have been approved for aquatic use by the U.S. Environmental Protection Agency (USEPA) and are registered for use by the California Department of Pesticide Regulation (CDPR) will be used for vegetation control activities. ▪ Herbicide application will be consistent with Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) label instructions and use conditions issued by USEPA, CDPR, and the Alameda County Agricultural Commissioner. ▪ Herbicides will not be applied in upland areas within 48 hours of predicted rainfall. ▪ The lowest recommended rates of herbicides and surfactants that achieve project objectives will be utilized to achieve desired control. ▪ An indicator dye may be added to the tank mix to help the applicator identify areas that have been treated and to better monitor the overall application. ▪ Herbicides will not be applied in open water or to plants whose bases are submerged in a stream channel or other water body. Application of herbicides to plants growing directly in water or within a stream channel (top-of-bank to top-of-bank) or its riparian corridor (drip line of trees growing on the top-of-bank) is not covered under this Plan and requires additional authorizations according to state and local regulations.

APPENDIX I
Best Management Practices for General Operations, Vegetation Management, and Protection of Biological Resources

BMP Number	BMP Title	BMP Description
Biological Resources		
BIO-1	Minimize Impacts to Nesting Birds via Site Assessments and Avoidance Measures	▪ For activities occurring between February 1 and August 31, project areas will be checked by a qualified biologist, for nesting birds within 2 weeks prior to starting work. If a lapse in project-related work of 2 weeks or longer occurs, another focused survey will be conducted before project work can be reinitiated. ▪ If nesting birds are found, a buffer will be established around the nest and maintained until the young have fledged. Appropriate buffer widths are 250 feet for raptors, herons, and egrets; 25 feet for ground-nesting non-raptors; and 50 feet for non-raptors nesting on trees, shrubs and structures. A qualified biologist may identify an alternative buffer based on a site specific-evaluation. No work within the buffer will occur without written approval from a qualified biologist, for as long as the nest is active. ▪ The boundary of each buffer zone will be marked with fencing, flagging, or other easily identifiable marking if work will occur immediately outside the buffer zone. ▪ All protective buffer zones will be maintained until the nest becomes inactive, as determined by a qualified biologist. ▪ If monitoring shows that disturbance to actively nesting birds is occurring, buffer widths will be increased until monitoring shows that disturbance is no longer occurring. If this is not possible, work will cease in the area until young have fledged and the nest is no longer active.
BIO-2	Protection of California Red-legged Frogs from Herbicide Use	▪ In accordance with BMP VEG-2, only herbicides approved for use by USEPA and registered for use by CDPR will be used for vegetation management, and approved herbicides will be applied in accordance with federal, state, and local regulations. ▪ In accordance with BMP VEG-2, no herbicides will be applied in open water. ▪ In project areas identified as providing suitable habitat for the California red-legged frog, the City shall ensure that any applications of sprayable or dust formulations of herbicides will: 1. be applied only when the air is calm or moving away from red-legged frog habitat; 2. begin in the portion of the work area nearest the suitable habitat and proceed away from the habitat; and 3. not be conducted within 40 yards upwind of suitable habitat when air currents are moving toward the habitat.
BIO-3	Avoid Special-Status Plant Species	If ground-disturbing equipment, such as a masticator, is to be used for vegetation management, the fuel management areas will be pre-surveyed for pallid manzanita (*Arctostaphylos pallida*), Oakland star-tulip (*Calochortus umbellatus*), Presidio clarkia (*Clarkia franciscana*), western leatherwood (*Dirca occidentalis*),

BMP Number	BMP Title	BMP Description
Biological Resources		
		Tiburon buckwheat (*Eriogonum luteolum* var. *caninum*) and bristly leptosiphon (*Leptosiphon acicularis*). To avoid and/or minimize potential impacts on special-status plants, the following actions will be taken: 1. Pre-maintenance surveys of the work area for special-status plant species will be conducted by a qualified biologist during the appropriate blooming period, within 2 years before commencement of work. 2. If special-status plant species are present at the work site, the qualified biologist will minimize impacts on them by implementing one or more of the following measures: A. Flag or otherwise delineate in the field the special status plant populations and/or sensitive natural community to be protected; B. Allow adequate buffers around plants or habitat; the location of the buffer zone will be shown on the maintenance design drawings and marked in the field with stakes and/or flagging in such a way that exclusion zones are visible to maintenance personnel without excessive disturbance of the sensitive habitat or population itself (e.g., from installation of fencing).; and C. Time construction or other activities during dormant and/or non-critical life cycle period.
BIO-4	Protection of California Red-legged Frogs and Western Pond Turtles	A qualified biologist shall review vegetation treatment areas to confirm whether the area provides suitable habitat for California red-legged frogs or western pond turtles. The biologist shall refer to Table 3 of the Biological Resources Report and conduct additional desktop analysis to determine whether the specific treatment areas provide suitable habitat or connectivity to suitable habitat for these species. Additional site visits may also be needed to confirm habitat for these species. In vegetation treatment areas identified as providing suitable habitat for California red-legged frogs or western pond turtles, a qualified biologist will conduct one daytime survey for these species within 48 hours before commencement of vegetation management activities. 1. If no California red-legged frogs or western pond turtles are found within the activity area during the survey, the work may proceed. 2. If a California red-legged frog or western pond turtle, or the eggs or larvae of either of these species, are found within the activity area during the survey or during project activities, the qualified biologist will implement the following measures: A. For vegetation management activities that will take less than 1 day, conduct a survey for red-legged frogs and western pond turtles on the morning of and before the scheduled work.

BMP Number	BMP Title	BMP Description
Biological Resources		
		I. If no California red-legged frogs or western pond turtles are found, the work may proceed. II. If eggs or larvae of either species are found, a no-disturbance buffer zone will be established around the location of the eggs/larvae. Work may proceed outside of the buffer zone; however, work within the buffer zone will be postponed until the eggs have hatched and/or larvae have metamorphosed. The monitoring biologist will determine the buffer size based on the specific site conditions and type of vegetation management. III. If an active western pond turtle nest is detected within the vegetation management area, a 25-foot buffer zone around the nest will be maintained during the breeding and nesting season (April 1–August 31). The buffer zone will remain in place until the young have left the nest, as determined by a qualified biologist. IV. If adults or non-larval juvenile California red-legged frogs or western pond turtles are found, the qualified biologist will implement one of the following two procedures: a.) If, in the opinion of the qualified biologist, the individual(s) are likely to leave the work area on their own, and work can be feasibly rescheduled, a buffer zone will be established around the location of the individual(s). Work may proceed outside of the buffer zone. Work within the buffer zone will be postponed until the individual(s) have left the area, as determined by the qualified biologist. The monitoring biologist will determine the buffer size based on the specific site conditions and type of vegetation management. b.) If, in the opinion of the qualified biologist, capture and removal of the individual to a safe location outside of the work area is less likely to result in adverse effects than leaving the individual in place and rescheduling the work (e.g., if the species could potentially hide and be missed during a follow-up survey), the individual will be captured and relocated by a qualified biologist (with USFWS and/or CDFW approval, depending on the listing status of the species in question), and work may proceed. B. For vegetation management that will take more than 1 day, the qualified biologist will conduct a survey for California red-legged frogs and western pond turtles each morning before the scheduled work commences. I. If eggs or larvae of either species are found, a buffer zone will be established around the location of the eggs/larvae and work may proceed outside of the buffer zone. Work within the buffer zone will be postponed until the eggs have hatched and/or larvae have

BMP Number	BMP Title	BMP Description
Biological Resources		
		metamorphosed. The monitoring biologist will determine the buffer size based on the specific site conditions and type of vegetation management. II. If an active western pond turtle nest is detected within the vegetation management area, a 50-foot buffer zone around the nest will be established and maintained during the breeding and nesting season (April 1–August 31). The buffer zone will remain in place until the young have left the nest, as determined by a qualified biologist. III. If adults or non-larval juvenile California red-legged frogs or western pond turtles are found, the individual(s) will be captured and relocated by a qualified biologist (with USFWS and/or CDFW approval, depending on the listing status of the species in question), and work may proceed.
BIO-5	Protection of Alameda Whipsnake	1. Prior to implementing vegetation treatments in Alameda whipsnake habitat, personnel involved in vegetation removal and earth-disturbing activities shall participate in an Environmental Awareness Training. Under this plan, workers shall be informed about Alameda whipsnake and their habitat, conservation goals, identification, and procedures to follow in the event of a possible sighting. 2. Any scrub habitat present within a vegetation treatment area shall be inspected by a qualified biologist prior to treatment to determine the presence or potential presence of Alameda whipsnakes. 3. To the maximum extent practicable, vegetation clearing activities in coastal scrub habitats will be scheduled to avoid the breeding period for the Alameda whipsnake (March 15 through June 15). 4. A qualified biological monitor will monitor vegetation removal and ground disturbance within Alameda whipsnake habitat, or other activities that may result in take of Alameda whipsnake. The biological monitor will have the authority to stop any work that could result take of Alameda whipsnake. 5. The biological monitor will inspect the treatment area for Alameda whipsnake each day before work begins by checking debris piles, and also beneath vehicles/equipment before it is moved. 6. If erosion control is needed, plastic monofilament netting or similar material containing netting will not be used, as Alameda whipsnake may become entangled in this material. Coconut coir matting or tackified hydroseeding compounds may be used instead.
BIO-6	Grazing	1. Livestock will generally be excluded from riparian areas. 2. Livestock will be excluded from known locations of special-status plant species.

<table>
<tr><th>BMP Number</th><th>BMP Title</th><th>BMP Description</th></tr>
<tr><td colspan="3">Biological Resources</td></tr>
<tr><td></td><td></td><td>3. Livestock will be monitored to ensure over-grazing of treatment areas does not occur. Grasslands should not be grazed to less than 4 inches.</td></tr>
<tr><td>BIO-7</td><td>Trash Removal</td><td>The contractor will be required to keep all waste and contaminants contained and remove them daily from the work site. Wildlife-proof trash receptacles will be used. Uneaten human food and trash attracts predators of the California red-legged frog and Alameda whipsnake. A litter control program will be instituted at each vegetation treatment site. All workers will ensure their food scraps, paper wrappers, food containers, cans, bottles, and other trash are deposited in covered or closed trash containers. The trash containers will be removed from the vegetation treatment site at the end of each working day.</td></tr>
<tr><td>BIO-8</td><td>Protection of Bat Colonies</td><td>To minimize impacts on special-status bats (e.g., pallid bat, western mastiff bat, and western red bat) and large colonies of non-special-status bats, the City will implement the following restrictions on tree trimming and removal activities:
1. If high-quality habitat for roosting bats (i.e., large trees with cavities of sufficient size to support roosting bats, as determined by a qualified bat biologist) is present, within 2 weeks before the commencement of work activities, a qualified bat biologist will conduct a survey to look for evidence of bat use. If evidence is observed, or if high-quality roost sites are present in areas where evidence of bat use might not be detectable (such as a tree cavity), an evening survey and/or nocturnal acoustic survey may be necessary to determine if a bat colony is present and to identify the specific location of the bat colony.
2. If no active maternity colony or non-breeding bat roost is located, work can continue as planned.
3. If an active maternity colony or non-breeding bat roost is located, work will be redesigned to avoid disturbance of the roosts, if feasible.
4. If an active maternity colony is located and work cannot be redesigned to avoid removal or disturbance of the occupied tree or structure, disturbance will not take place during the maternity roost season (March 15–July 31), and a disturbance-free buffer zone (determined by a qualified bat biologist) will be observed during this period.
5. If an active non-breeding bat roost is located and work cannot be redesigned to avoid removal or disturbance of the occupied tree or structure, the individuals will be safely evicted between August 1 and October 15 or between February 15 and March 15. Bats may be evicted through exclusion after notifying CDFW. Trees with roosts that need to be removed will first be disturbed at dusk, just before removal that same evening, to allow bats to escape during the darker hours.</td></tr>
</table>

APPENDIX I
Best Management Practices for General Operations, Vegetation Management, and Protection of Biological Resources

BMP Number	BMP Title	BMP Description
Biological Resources		
BIO-9	Protection of dusky-footed woodrats	1. If a woodrat nest is identified in a work area, the City will attempt to preserve the nest and maintain an intact dispersal corridor between the house and undisturbed riparian habitat. 2. If the woodrat nest cannot be avoided, a qualified biologist shall deconstruct the nest by hand and relocate the nest materials to the nearest undisturbed suitable riparian habitat.
BIO-10	Seeding with Native Species	The City shall reseed exposed soil resulting from Plan activities as follows: 1. Sites where vegetation management activities result in exposed soil will be stabilized to prevent erosion. Disturbed areas shall be seeded with native seed as soon as is appropriate after vegetation management activities are completed. An erosion control seed mix may be applied to exposed soils, down to the OHWM. 2. The seed mix should consist of California native grasses (e.g., *Hordeum brachyantherum*, *Elymus glaucus*, and *Festuca microstachys*) or annual, sterile seed. 3. Temporary earthen access roads may be seeded when site and horticultural conditions are suitable, or may have other appropriate erosion control measures in place.

APPENDIX J

Draft Protected and Endangered Species Policy and Procedures

OAKLAND FIRE DEPARTMENT
POLICY AND PROCEDURES

APPROVED:

REFERENCE:	Fire Prevention Bureau
NUMBER:	TBD
EFFECTIVE:	TBD
REVISED:	

____

PROTECTED AND ENDANGERED SPECIES

I. PURPOSE:

To establish a uniform procedure for the protection of state- and federally-listed Endangered or Threated species of flora or fauna, and non-listed species otherwise protected by state and/or federal statutes (collectively "Protected Species"), when identified as being present on or within areas of City responsibility or ownership while conducting vegetation and fuels management practices within the designated Very High Fire Hazard Severity Zone of the City of Oakland.

II. DEFINITIONS:

A. FIRE HAZARD SERVERITY ZONE (FHSZ): An area that has been evaluated by the California Department of Forestry and Fire Protection (Cal Fire) on several factors, including: fuel, slope and fire weather, and was ultimately determined by Cal Fire to have varying degrees of a fire hazard (i.e. moderate, high and very high).

B. PROTECTED SPECIES: state- and federally-listed Endangered or Threated species of flora or fauna, and non-listed species otherwise protected by state and/or federal statutes.

III. POLICY:

A. Supervisor & Inspectors assigned to the Vegetation Management Unit shall refer to the City's adopted Vegetation Management Plan for guidance when drafting contracts for roadside clearance abatement, City owned vacant lot clearance abatement, parks and open space grazing, and fuel reduction abatement.

B. When necessary, the City shall utilize qualified biological consultants to ensure that Protected Species are avoided during its vegetation management activities. Consultants authorized by the City shall have demonstrated past experience conducting biological assessments for Protected Species and developing and implementing avoidance strategies for such species. Upon completion and subsequent implementation of its Vegetation Management Plan, the work of consultants shall be guided by the Plan.

C. When appropriate, the City shall contract with and utilize qualified biological consultants (Environmental Consultant) to ensure that Protected Species are avoided during its vegetation management activities. Consultants authorized by the City shall have demonstrated past experience conducting biological assessments for Protected Species and developing and implementing avoidance strategies for such species.

D. Prior to the initiation of any vegetation management activities, the contracted Environmental Consultant shall review and compile species location data from recognized resource agency databases (California Natural Diversity Database [CNDDB] from the California Department of Fish and Wildlife [CDFW], IPaC from U.S. Fish and Wildlife Service [USFWS], etc.) relevant to the area in which such activities will occur. Any locations of Protected Species on City-owned parcels and adjacent to roadways (within 50 feet) where vegetation management will occur will be provided to the City.

E. In areas where vegetation management activities are proposed and in which Protected Species may occur based on the review of the agency species location database and/or on the presence of suitable habitat, the Environmental Consultant shall conduct a site visit, during the appropriate blooming (plants) and breeding (animals) period of the target Protected Species, to determine presence/absence of Protected Species. If Protected Species are observed, occupied areas will be "flagged" for visual recognition with "Fire Line, Do Not Cross" marking tape to prevent intrusion and disturbance of the Protected Species by abatement crews. The avoidance area will be determined by the Environmental Consultant and will consider the nature and extent of the vegetation/fuel management activity, time of year, and species being protected. If the species is state- or federally-listed as Threatened or Endangered, consultation with the appropriate resource agency may need to occur prior to initiation of vegetation management activities.

F. Abatement contracts released for competitive bid shall identify which Protected Species are present (if applicable) and a detailed map provided which will advise the awarded abatement contractor of the locations "flagged" as described in Item D above. These locations shall not be intruded upon or disturbed.

G. In situations where Protected Plant Species must be allowed to "go to seed" for propagation (native bunch grasses and flowering plants), contracts for vegetation removal or grazing shall be suspended until such time that the flora has completed its growth cycle and can safely be cut or grazed over. These locations may be fenced or flagged, and the adjacent vegetation removed if conditions dictate that surrounding overgrowth be abated in the interest of public safety and fire prevention and would not result in adverse impacts to any Protected Species.

H. In situations where Protected Wildlife Species are breeding (e.g., nesting birds), contracts for vegetation removal or grazing shall be suspended until such time that the young of the species has fledged or is otherwise not dependent upon the nest, burrow, or other breeding substrate for survival and the vegetation can safely be cut or grazed over. These locations may be fenced or flagged, and the adjacent vegetation removed if conditions dictate that surrounding overgrowth be abated in the interest of public safety and fire prevention and would not result in adverse impacts to any Protected Species.

I. If take of any state- or federally-listed Protected Species is expected to occur, the City shall obtain an Incidental Take permit from the appropriate agency (CDFW or USFWS). Such permit(s) will be secured by the City's Planning Department / Environmental Services Division in accordance with the California Endangered Species Act, section 2081, California Code of Regulations Title 14, section 783 or Section 10 (a)(1)(B) of the federal

Endangered Species Act prior to the initiation of any vegetation/fuel management activities. Any unintended incidental take of a listed Protected Species during the course of approved vegetation management activities shall be reported to the Supervisor of the Vegetation Management Unit for documentation and reported to the appropriate resource agency (CDFW or USFWS).

J. Fire Prevention Bureau staff assigned to the Vegetation Management Unit shall communicate with City of Oakland Parkland Resources Supervisor(s) when drafting contracts for fuels abatement within designated City Parks and Open Spaces to confirm locations of proposed fuel breaks and to identify any Protected Species of both flora and fauna which may be present and impacted by such abatement measures to ensure habitat preservation and protection of Protected species. In such cases, abatement practices shall be modified as needed.

IV. PROCEDURES:

A. Plants

If ground-disturbing equipment, such as a masticator, is to be used for vegetation management in areas known to support or potentially support Protected Plant Species, the fuel management areas will be pre-surveyed for Protected Plant Species. To avoid and/or minimize potential impacts on these species, the following procedures will be taken:

1. Pre-maintenance surveys of the work area for Protected Plant Species will be conducted by the Environmental Consultant during the appropriate blooming period within 2 years before commencement of work.

2. If Protected Plant Species are present at the work site, the Environmental Consultant will minimize impacts by implementing one or more of the following measures:

    a. Flag or otherwise delineate in the field the plant populations and/or sensitive natural community to be protected;

    b. Allow adequate buffers around plants or habitat; the location of the buffer zone will be shown on the maintenance design drawings and marked in the field with stakes and/or flagging in such a way that exclusion zones are visible to maintenance personnel without excessive disturbance of the sensitive habitat or population itself (e.g., from installation of fencing).; and

    c. Time construction or other activities during dormant and/or non-critical life cycle period.

B. Wildlife

If ground-disturbing equipment or pruning or other tree/shrub modification activities will occur in areas known to support or potentially support Protected Wildlife Species, the fuel management areas will be pre-surveyed for Protected Wildlife Species. To avoid and/or minimize potential impacts on these species, the following procedures will be taken:

1. The Environmental Consultant will conduct pre-activity surveys for nesting birds during the nesting season (typically March through August). If active nests are found within or adjacent to fuel management areas, an appropriate buffer, as determined by the Environmental Consultant, will be established and fuel modification activities will not be conducted within these buffer areas until the nest is inactive as determined by the Environmental Consultant.

2. The Environmental Consultant will conduct pre-activity surveys for non-avian Protected Wildlife Species during the appropriate breeding season. If located, appropriate measures will be taken to avoid/minimize adverse impacts to such species. Such measures can include, but would not be limited to, the installation of exclusion fencing, monitoring during fuel modification activities, establishment of protective buffers, and trapping and relocation of potentially affected animals.

C. General

1. Favor thinning techniques that do not result in substantial ground disturbance (such as hand thinning, thinning using a chainsaw, mowing, or mastication) over techniques that result in ground disturbance (such as grapple piling or blading), whenever this can be done with no loss of fuel management effectiveness.

2. If feasible, rather than using heavy equipment for thinning, explore the use of alternative mechanized equipment with greater reach or less ground pressure exerted per square inch to reduce soil compaction and/or total area disturbed.

3. When fuel reduction measures necessitate ground disturbance and soil exposure or removal of substantial ground cover and canopy, cover and reduce exposure of bare ground using on-site chipping or woody debris from mastication.

APPENDIX K

Stakeholder/Volunteer Groups in the Plan Area

APPENDIX K
Stakeholder/Volunteer Groups in the Plan Area

Park	Stakeholder/Volunteer Group	Contact	Email
Montclair Railroad Trail	Friends of Montclair Railroad Trail	Lin Barron	lbarron_510@att.net
Shephard Canyon Park	Shepard Canyon Home Owners	Mike Petouhoff	mike.petouhoff@yahoo.com
	Friends of Sausal Creek	John Taylor	coordinator@sausalcreek.org
Joaquin Miller Park	Friends of Joaquin Miller Park	Stan Dodson	stan@oaklandtrails.org
		Sue Duckles	spduckle@uci.edu
		Emily Rosenberg	odogparks@comcast.net
		Karen Paulsell	kpaulsell@pacbell.net
	Friends of Sausal Creek	Anna Marie Schmidt	coordinator@sausalcreek.org
North Oakland Sports Field	Oakland Landscape Committee	Gordon Piper	rgpiper33@gmail.com
		Sue Piper	susangpiper@gmail.com
Garber Park	Garber Park Stewards	Shelagh Brodersen	garberparkstewards@gmail.com
	Claremont Canyon Conservancy		info@ClaremontCanyon.org
Leona Heights Open Space	Friends of Leona Heights Park	Christopher Cook	greenrosettas@gmail.com
		Grace Neufeld	grace@baywoodlearningcenter.org
			friendsofleonaheightspark@gmail.com
Dimond Park	Friends of Dimond Park	Stan Dodson	stan@oaklandtrails.org
		Opie Bellesis	bellas123@aol.com
	Friends of Sausal Creek		coordinator@sausalcreek.org
Beaconsfield Canyon	n/a	Richard Kauffman	richard@rkcommunications.com
		Wendy Tokuda	w.s.tokuda@gmail.com
	Friends of Sausal Creek		coordinator@sausalcreek.org
Knowland Park	Friends of Knowland Park	Scott Wedge	swopw@xemaps.com
		Elise Bernstein	elisebernstein@gmail.com
		Beth Wurzburg	wurzburg.beth@gmail.com
		Laura Baker	lbake66@aol.com
		Karen Asbelle	karen.asbelle@gmail.com
King Estate Open Space	Oak Knoll Neighborhood Improvement Association	Philip Dow	pdow@mindspring.com
		Brian Smalley	briansma@sbcglobal.net
		Marshall Hasbrouck	mhasbrouck@yahoo.com
Marjorie Saunders Park	Piedmont Pines Neighborhood Association	n/a	info@piedmontpines.org